Environmental Impact Analysis Process

Final Environmental Impact Statement

Volume I

Proposed

High Frequency Active Auroral Research Program

July 1993

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DEPARTMENT OF THE AIR FORCE

Air Force Materiel Command

Phillips Laboratory

Cooperating Agency:

DEPARTMENT OF THE NAVY

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(e) Abstract: This FEIS consists of two volumes. Volume I represents a corrected version of the Draft Environmental Impact Statement (DEIS) and Volume II presents the results of public comment on the DEIS. The FEIS describes the potential environmental impacts of constructing and operating a proposed ionospheric research facility in interior Alaska. The system is referred to as HAARP (High-frequency Active Auroral Research Program), and would be used primarily for conducting pioneering studies of ionospheric properties. This proposed facility would be the most technologically advanced in the world. The program could lead to a better understanding of the ionosphere and enable researchers to develop methods for enhanced communications for both civilian and defense applications. The HAARP system consists of a powerful high frequency radio transmitter, referred to as the ionospheric research instrument, and a number of scientific data gathering (diagnostic) instruments.

Through the application of both research and siting constraints, two potential candidate sites were identified in Alaska; Clear and Gakona. This document addresses three alternatives associated with the construction of the HAARP facility; namely, construction at either Clear or Gakona, and the no action alternative. Issues and resources that were examined for both of the sites include land and minerals, vegetation and wetlands, mammals, birds, aquatics, hydrology and water quality, air quality, socioeconomics, cultural resources, subsistence, recreation, aesthetics, possible bioeffects of radio frequency radiation, electromagnetic environment and radio frequency interference, atmosphere, threatened and endangered species, hazardous materials and wastes, and irretrievable commitment of resources. Based on comments received on the DEIS, an additional analysis relating to acoustical noise was added to this document. Key concerns for the Gakona site include radio frequency interference, cost of construction, permafrost degradation and subsidence issues, impacts on migrating birds, and the availability of and access to gravel sources. Key concerns for the Clear site include land ownership and wetlands issues, disturbance of cultural resources, radio frequency interference, aesthetic impacts, and the near-term reclamation of the Gakona site.

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SUMMARY

FINAL ENVIRONMENTAL IMPACT STATEMENT (FEIS)

CONSTRUCTION AND OPERATION OF AN IONOSPHERIC RESEARCH FACILITY FOR THE HIGH FREQUENCY ACTIVE AURORAL RESEARCH PROGRAM

Purpose and Need for Action

The High-frequency Active Auroral Research Program (HAARP) is a scientific endeavor aimed at studying basic properties and behavior of the ionosphere, with particular emphasis placed on being able to better understand and use it to enhance communications and surveillance systems for both civil and defense purposes. The HAARP system, if constructed, would allow a significant advance in man's ability to investigate the upper atmosphere.

The environmental analysis and impact study for this action focuses on the following resources and issues: land and minerals; vegetation and wetlands; mammals; birds; aquatics; hydrology and water quality; air quality; cultural resources; subsistence; bioeffects of radio frequency radiation; electromagnetic environment and radio frequency interference; atmosphere; threatened and endangered species; hazardous materials and wastes; and, irretrievable commitment of resources. In addressing these subject areas, the FEIS is divided into three main sections: proposed action and alternatives; affected environment; and environmental consequences and mitigation.

Description of Proposed Action and Alternatives

The government proposes to construct the HAARP facility in Alaska. At the HAARP facility research that cannot be accomplished within traditional ground-based laboratories would be conducted on the earth's upper atmosphere and within the ionosphere. The main element of the research facility would be a large radio wave transmitter. Similar, though less capable, research facilities exist at many locations throughout the world and are operated routinely for the purpose of scientific investigation of the ionosphere. In the U.S. its territories such systems are located at Arecibo, Puerto Rico and Fairbanks, Alaska. Other installations are at Tromso, Norway; Moscow, Nizhny Novgorod and Apatity, Russia; Kharkov, Ukraine and Dushanbe, Tadzhikistan. None of these existing systems, however, are effective enough to perform the experiments planned for HAARP. Users of the HAARP research facility would include universities, the U.S. Air Force, the U.S. Navy, and other government agencies such as the National Science Foundation and Advanced Research Projects Agency.

HAARP site selection criteria were developed from both research requirements and siting constraints. Research constraints stipulated that the selected site must fall in the range of latitudes between 61 and 65 degrees, either north or south. This latitude provides the proper mix of active and inactive auroral states. Siting constraints included that the site must be: on U.S. soil, on Department of Defense (DOD) land to the maximum extent practical, near a major highway, away from densely settled areas, of sufficient acreage to allow for equipment siting and separation space, on relatively flat terrain, and of realistic and reasonable environmental impacts and construction and operation costs.

Numerous alternatives were initially considered for location of the HAARP facility, including upgrading of existing ionospheric research facilities or a totally new construction effort. Upgrading an existing facility near Fairbanks was initially considered, but it was determined that the upgraded system would cause large numbers of interference problems in this relatively developed area. At that point, new areas were examined for the siting of HAARP. Of the sites considered, only three made it through the application of the selection criteria. The three sites were: Clear AFS, Gakona [at a partially constructed Over-the-Horizon Backscatter (OTH-B) radar site], and Fort Greely, Alaska. Siting HAARP at the Clear site could be accomplished only by locating some of the diagnostic equipment on a separate parcel due to interference between the Clear AFS Ballistic Missile Early Warning System (BMEWS) and a critical HAARP instrument. Conflict with military operations at Fort Greely was determined irreconcilable, and Fort Greely was dropped from further consideration. As a result, the Gakona and Clear sites were deemed the only two sites meeting the criteria of the program.

In addition to examining geographical siting alternatives, two design alternatives were also considered; a dual array and a stacked array ionospheric research instrument. The dual array would consist of a high-frequency and a low-frequency antenna mast system located adjacent to one another. In the stacked array system, the two arrays would be mounted on the same antenna masts. The result is that the stacked array system would involve roughly half the level of disturbance to the environment and lower construction costs. Since the stacked array was obviously preferable, the dual array was dropped from further consideration.

The HAARP equipment would consist of the following major items: an Ionospheric Research Instrument (IRI); an Incoherent Scatter Radar (ISR); a Vertical Incidence Sounder (VIS); an Optical Imager and Magnetometer; and a Light Detection And Ranging (LIDAR) unit. Each of these separate items would have support buildings, equipment and facilities associated with them. The IRI would be the main component of the HAARP system and would consist of 180 antenna masts approximately 70 feet above the ground, laid out in a 12 by 15 grid format, with each mast set 80 feet on center. The ISR would be the most critical diagnostic equipment and would consist of a large parabolic dish antenna measuring 115 feet in diameter and mounted on an approximately 35-foot high pedestal. The VIS would consist of both a transmit and a receive unit. The transmitter would consist of five antenna masts; four 50-foot high masts arranged in a square configuration, with a 100-foot high mast in the center. The optical imager and magnetometer instruments would be enclosed in a three-foot by three-foot by one and half-foot high box surrounded by a restriction fence. The receiver would consist of four elements each

four to five feet high and mounted in a triangular configuration with one unit in the center. A LIDAR is an optical instrument which would be located in an enclosed module with a transparent dome on the roof. The physical appearance and layout of these instruments would be similar at each of the sites, with the exception of the ISR and VIS units at the Clear site. These would be located 10 miles south of Clear AFS to avoid interference with the BMEWS.

Construction at the Gakona site would involve the importation of substantial quantities of gravel (approximately 160,000 cubic yards) to minimize the melting of the ice-rich permafrost. The Clear site is underlain by a large glacio-fluvial outwash plain consisting of well drained sand and gravel allowing for simplistic construction approaches. Construction at the Clear site would be somewhat simpler, less expensive, and less risky than at the Gakona site due to the better subsurface conditions. Total quantity of gravel required for construction at the Clear site is estimated at 32,000 cubic yards.

The preferred alternative is to construct and operate the HAARP facility at a site in Gakona, Alaska.

Public Concerns

The program has solicited input from the local communities on several occasions. Early in the environmental impact analysis process two scoping meetings were held, one in Glennallen and one in Anchorage to determine the local concerns. These concerns were used to identify subject areas analyzed in the environmental impact statement. After publishing the DEIS, the program held public hearings in Glennallen and Anderson to solicit further input from the public and answer any questions they might have about the DEIS. Additionally, citizens and state and federal agencies were asked to submit written comments on the DEIS. Comments received and responses to comments are published in the FEIS.

Below is a brief synopsis of the areas of concern raised during the public review process:

- Electromagnetic interference with various electronic systems, especially with communications and aviation systems

- Bioeffects from radio frequency radiation on both humans and wildlife

- Utilization of local labor for HAARP construction and operation

- Level of detail in the DEIS, public review period, and notification of DEIS publication and public hearings

- Impacts on fish and wildlife associated with gravel mining activities near the Copper River and Tulsona Creek

- Bird collisions with the IRI and VIS antenna masts
- Noise impacts associated with construction and operation
- Impacts on the upper atmosphere, and particularly the ozone layer

Other issues raised less frequently have also been discussed and answered within this FEIS.

Comparison of Environmental Consequences of Alternatives

The Gakona site's primary positive attributes are lower aesthetic impacts to tourists and area residents, less wetlands to be filled, less disruption of homesteaders, and no land acquisition. The Clear site's primary positive attributes relate to a lower increment in air pollution generation, base utilities systems available for HAARP use, easier construction techniques and the Gakona site reclamation. The no action alternative would be environmentally preferred as it would result in the existing Gakona site being reclaimed, with a net positive environmental effect.

Identification of the Preferred Alternative

The preferred alternative is to construct the HAARP facility at the Gakona site. Utilization of the Gakona site allows for the entire HAARP system to be constructed on one parcel of land currently owned by the Air Force, with minimal disruption to existing residents of the area. Re-use of the Gakona site and its facilities would preclude the near-term and costly reclamation effort associated with the demolition of the large powerplant building and the removal of drainage culverts from the access road. Impacts to wetlands would be minimized by siting HAARP at Gakona rather than Clear.

Affected Environment

Information on the affected environment was obtained from local, state and federal government agencies, as well as from local individuals and private businesses in the region and site visits. In the case of Gakona, much of the information was obtained from the OTH-B program studies. The Gakona site is near mile 11.2 of the Tok Cut-Off Highway in the Copper River Basin. All of the land to be used at the Gakona site is owned by the Air Force. A one-mile access road and a large building exists at Gakona for use by HAARP. The Clear site is in the Tanana-Kuskokwim Lowland region in the Nenana River drainage. The majority of the land to be used at the Clear site is owned by the Air Force, although some property on a separate parcel would have to be acquired from the state of Alaska or private individuals for siting of the ISR and VIS instruments.

The Gakona site is primarily open conifer forests and wetlands. The installation would use a total of about 51 acres at the Gakona site. The Clear site is primarily black spruce forest and wetlands, with some young mixed deciduous/conifer areas. The installation would use a total

of about 78 acres at the Clear site. Each of the sites provides habitat for moose, bears (black and brown), wolves, and other furbearers. The Gakona site is used by the Nelchina caribou herd, while the Clear site is in an area not considered prime caribou range. Birds at each of the sites include waterfowl, song birds, and raptors. Although arctic and american peregrine falcons (listed as threatened and endangered species respectively) migrate through the Clear site region, no evidence of falcon breeding in the immediate areas has been documented. Neither of the sites contain any significant aquatic resources. River systems in the areas of the sites do have both resident and migratory fish.

Both sites are located near major rivers: the Gakona site near the Copper River; and, the Clear Site near the Nenana River. The potential for flooding at both of the sites is minimal. The Gakona site is characterized by a low yield poor quality aquifer while the Clear site has a high yield high quality aquifer. The climate at each of the sites is typical for interior Alaska; warm pleasant summers and long cold winters with light winds being the norm. Typical precipitation for the sites range from 10 to 15 inches per annum. Both airsheds are classified as Class II by state standards. A diesel powerplant would be completed at the Gakona site to supply HAARP with the majority of the required power. At the Clear site electrical power would either be provided by the existing (possibly modified or expanded) Clear AFS coal-fired plant, and/or by the commercial power source in the area.

Both the Clear and Gakona sites are located in regions that would be classified as rural by most standards. The largest town in the Gakona region is Glennallen (450 residents), while the largest towns in the Clear region are Anderson and Healy at 628 and 487 residents, respectively. Both areas provide excellent room and board services for communities their size. The Clear region is very rich in archeological sites, while the Gakona site is less important from an archeological perspective. Ongoing subsistence activities are important within each of the site's region of influence. Recreational issues are of concern in the Clear region because of the nearby Nenana River and Denali National Park. Recreational issues at the Gakona site are possibly of less concern, although a U.S. Bureau of Land Management (BLM) hunting and fishing trail extends through the area and Wrangell - St. Elias National Park is within one mile of the site. Aesthetic concerns at the Clear site may be significant because the ISR/VIS site could be visible from the highway, river and train tracks. Views of the Gakona site are obscured by thick vegetation.

Both the Gakona and the Clear regions contain electromagnetic equipment that could be affected by the operation of the HAARP facilities.

Minimal amounts of hazardous materials are used and generated at the Gakona site through the existing caretaking activities of the powerplant building. This would include petroleum based products and paints, solvents, and janitorial-type supplies. There are no known hazardous materials at the Clear site in the areas being proposed for HAARP equipment. Clear AFS has numerous hazardous substances associated with operation and maintenance of a installation of its type.

Environmental Consequences and Mitigation

The consequences of constructing the HAARP facility at each of the sites is summarized here, along with suggested mitigative measures. Three alternatives are considered here, including Clear, Gakona, and no action. The consequences of selecting either the Clear site or the no action alternative include having to conduct the reclamation effort at the Gakona site.

Constructing the facility at the Clear site would require the acquisition of land from either the state or private individuals for the siting of the VIS and the ISR. Impacts would be minimized by final siting modifications at the location to limit the disturbance to private landowners, and the use of aesthetic engineering to minimize visual impacts. The major consequence to land and minerals from constructing at the Gakona site include the mining of large amounts of gravel, and the thermal disturbance of surrounding terrain. Mitigation of these consequences can be achieved by sound planning of the gravel mining operation and possible winter construction to minimize damage to the vegetative mat. The impact to land and minerals of the no action alternative (reclamation at Gakona) includes the transfer or sale of the government property at the Gakona site.

Vegetation loss at the Clear and Gakona site would be biologically and socially insignificant. About 51 acres of black spruce would be affected at the Gakona site and approximately 78 acres of black spruce and mixed deciduous conifer forest would be affected at the Clear site. About 18 acres of wetlands would be impacted at the Gakona site, while at the Clear site about 36 acres of wetlands would be impacted. The wetlands that would be filled at the Clear site are considered more important than those at the Gakona site because they produce more and better forage. Mitigation at both of the sites could be accomplished by modifying siting of equipment such that wetlands are avoided and by revegetating areas that are impacted. The impacts on vegetation of the no action alternative (reclamation at the Gakona site) include a slight positive impact at Gakona by the revegetation on the previously disturbed areas by native species.

No significant impact to mammals would result from the construction of the HAARP facility at either of the sites. Some loss of moose browse would result from the construction of HAARP at either the Gakona or Clear sites. However, at neither of the sites is moose browse a limiting factor. Impacts on mammal populations as a result of direct human caused mortality is considered insignificant. The selection of the no action alternative would result in a long-term creation of a small moose browse area as the gravel areas revegetate as uplands.

No significant impacts to birds would result from the construction of the HAARP facility at either of the sites. Habitat loss would be insignificant. Collision potential between the birds and the HAARP equipment is considered minimal regarding geese, ducks, raptors, shorebirds, and passerines, with the potential for swan collisions being low to moderate. Mitigation could include curtailing activities away from nesting and brood raising periods. Visibility of guy wires could be enhanced to minimize bird collisions. The no action alternative would have a slight positive impact. The large powerplant building would be removed, thereby eliminating the potential of collisions.

Aquatic impacts would be insignificant at either sites. The low potential impact on aquatics would come from erosion and siltation associated with the mining of gravel at the Gakona site. Other impacts could result from the accidental discharge of petroleum based products during construction or operation of HAARP facilities. Mitigation of the possible adverse consequences could include mining gravel from an area that will not cause erosion and siltation problems, construction of berms to contain runoff from overburden and gravel stockpiles, and through the use of contingency plans and spill prevention and detection systems. The no action alternative would have no significant impact on aquatics. There would be a slight potential for small petroleum spills during the reclamation effort outlined above.

Hydrological impacts at the Clear and Gakona sites would be insignificant and local water supplies would not be affected. Degradation of permafrost at Gakona could cause subsidence of the ground and alter the surface flow patterns. This could cause accelerated erosion in some areas. Disposal of waste products and accidental release of petroleum based products at either of the sites could cause a degradation of surface and sub-surface water quality. Mitigation could include limiting disturbance of vegetation during construction and operation, implementing a petroleum spill prevention and detection program during construction and operation, and the limiting of on-site disposal of waste products. The hydrologic impact of the no action alternative could include the further disruption of the permafrost at the Gakona site, thereby creating emerging drainage channels. Mitigation in this regard could include careful reclamation construction efforts, and the insertion of numerous drainage channels across the existing roadway to allow for more natural site drainage.

Air quality impacts at each site would result from construction activities and powerplant operations. At the Clear site, power would be provided by modifying or expanding an existing powerplant to increase output, and/or by purchasing power from a commercial grid. Either of these options would result in a nominal increase in air pollution. Use of the Gakona site would require the construction of a powerplant with an output capacity of about 15 megawatts. Depending upon the duration of powerplant operation, the PSD threshold for air quality potentially could be exceeded. Internal combustion engine emissions during construction and generation of fugitive dust is also a concern. Air quality impacts associated with the reclamation effort at Gakona for the no action alternative includes those limited to construction activities described above.

Socioeconomic impacts of the HAARP construction at either of the sites would result in short-term positive impacts to the region associated with construction. Local area labor would be used as much as possible to limit the number of imported workers to the areas. The required number of imported workers for the Gakona site would be larger than at the Clear site, since there is no nearby large populous areas, such as Fairbanks, from which to draw construction expertise. About 80 imported workers would be required for the Gakona site, and about 10 would be required for the Clear site. There is enough housing in each of the areas to easily accommodate the influx of construction workers. Mitigation could include maximum possible use of local labor at each of the sites. The no action alternative would result in a small positive economic impact in the Gakona area associated with the Gakona site reclamation effort, but the level of

impact would be much less than with the full construction alternative due to the scope of the activity. Mitigation of negative impacts could include use of local area labor to the greatest extent possible. Impacts to aircraft following nearby air traffic routes would be avoided through the incorporation of an aircraft detection system (included in the design). The system would turn off the appropriate emitters if an aircraft approaches the site.

Potential impacts on cultural resources associated with the construction of HAARP at the Clear site are much greater than at the Gakona site. Neither of the two National Register of Historic Places (NRHP) sites in the Clear area would be impacted. It is highly likely that archeological sites would be uncovered during construction at the Clear site, while the probability of discovery at the Gakona site is negligible. The Section 106 process of the National Historic Preservation Act (NHPA) would be complied with to minimize any potential impacts to cultural resources. The no action alternative would have no impact on cultural resources since construction reclamation efforts at the Gakona site would be limited to recent gravel fill areas.

Impacts on subsistence at both the sites include some short-term game redistribution as a result of construction activities, and minimal loss of habitat for subsistence species such as moose. The projected larger construction crew at the Gakona site could increase recreational hunting and fishing pressure in the area which could have an indirect impact on subsistence harvest rates. Mitigation would include the use of local area labor to minimize an increase in recreational pressure, and minimization of construction disturbance through management practices. Impacts on subsistence brought about by the no action alternative would be similar to those described above for the construction action.

Recreational impacts at the Gakona site would be relatively minor, being limited to aesthetic impacts as viewed from aircraft and the possible displacement of the BLM trail which runs through the site. Recreational impacts at the Clear site would result from conflicts with tourism and traveling on the highway, railroad, or floating on the Nenana River. Mitigation at the Gakona site would include maintaining access to lands north of the site either by allowing continued use of the BLM trail or by finishing the alternate access pathway previously started by the OTH-B program. Mitigation at the Clear site could include minimizing aesthetic impacts as described below. The no action alternative would have very little short-term impact on recreation, and the long-term impact would be positive in that the site clearing could be used to access areas previously difficult to reach for recreational purposes.

Aesthetic impacts of the proposed action at the Gakona site would be insignificant. Aesthetic impacts at the Clear site are more of an issue due to the scenic appeal of the proposed location of the ISR and VIS and their impacts on the natural vista as viewed from the Parks Highway, Alaska Railroad tracks and the Nenana River floating corridor. Mitigation at the site could include the use of trees or vegetation to minimize visual impact.

The bioeffects of radio frequency radiation (RFR) are expected to be non-existent, regardless of the site selected. Humans and animals are not expected to be affected outside of the exclusion fence being placed around the facilities. There would also be no expected effects to birds that

fly over or roost on top of the array. Bird migratory navigational systems are not anticipated to be affected by the operation of HAARP. There would be no RFR bioeffects from the no action alternative.

Electromagnetic systems that could be affected by HAARP operations at either of the sites could include high-frequency communications, mobile VHF radios, wildlife trackers, citizen band radios, hand held transceivers, UHF communications equipment, and television. Mitigation could include design modifications to minimize low angle radio emissions and out-of-band radio frequency energy, hardware modifications to the affected user system, avoidance of interfered frequencies and shutdown of appropriate HAARP emitters.

Atmospheric impacts include temporary (a few seconds to a few hours) changes in the density, temperature, and structure of the ionosphere. Those impacts would be negligible in comparison to those produced by the sun. The ozone layer would not be affected, and ozone would not be depleted. No mitigation would be necessary in regard to atmospheric impacts.

Hazardous materials required for HAARP operation at the Gakona site would include numerous petroleum based products, solvents, cleaners, paints, and janitorial-type supplies. Approximately 200,000 gallons of diesel fuel would be stored on-site for consumption by the power generation system. Hazardous materials at the Clear site would be similar to those mentioned above for the Gakona site, but the large quantities of diesel fuel would not be required since power would be obtained from the existing Clear AFS coal-fired powerplant and/or from a commercial source. Mitigation at each of the sites would include compliance with all applicable regulations, permits, and standards relating to the handling, transport, storage, and use of hazardous materials and wastes.

Irretrievable commitment of resources for the construction of the HAARP facility include fuel (primarily diesel fuel at the Gakona site and probably coal at the Clear site) for construction and operation, and construction products such as gravel, aggregate, sand, cement, metal, and wood. In addition, about 51 acres of land (18 acres of wetlands) at the Gakona site and 78 acres of land (37 acres of wetlands) at the Clear site would be occupied. The use of any of these resources is insignificant in comparison to the regional or national consumption. No mitigation in this subject area is appropriate.

Noise analysis performed on the construction and operation of the HAARP facility indicates that only minimal impacts would result from the operation of the six diesel engines and from the development of the borrow pit(s). Minimal impacts would result from haul truck noise or from site proper construction activities. Noise impacts from the operation of the six diesel engines would be mitigated by design modifications such as high volume, low pressure drop mufflers, or noise shields on the exhaust stacks. Borrow pit noise impacts on eagles would be mitigated through scheduling modifications to avoid critical periods and through the use of buffer zones around nests.

Conclusion

After the publication of the FEIS, the Air Force will decide which alternative identified in the FEIS should be selected. This decision follows a required minimum 30 day waiting period as specified in the regulations governing the environmental impact analysis process. At the end of that period, the Air Force will prepare a Record of Decision (ROD) to document its choice of the alternative. As an addendum to the ROD, the Air Force will prepare a mitigation plan which outlines the mitigation action to be taken to minimize any significant environmental impacts. An extensive study of the impacts has been completed and is incorporated in Volume I of this FEIS. This study covered a wide range of operational scenarios and concluded that some mitigation may be warranted.

It is anticipated that the Record of Decision will be signed in early August, 1993. Notification of the ROD will be made in the Federal Register and the local Alaska media similar to past program announcements. Copies of the ROD will be mailed to all individuals included on the FEIS distribution list. Additional copies of the ROD can be obtained by contacting the program office.

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LIST OF ABBREVIATIONS

AAAQS	Alaska Ambient Air Quality Standards
AAC	Alaska Administrative Code
ABR	Alaska Biological Research
ACHP	Advisory Council on Historic Preservation
ADEC	Alaska Department of Environmental Conservation
ADF	Automatic Direction Finder
ADFG	Alaska Department of Fish and Game
ADG&GS	Alaska Division of Geologic and Geophysical Surveys
ADL	Alaska Department of Labor
ADNR	Alaska Department of Natural Resources
ADOT	Alaska Department of Transportation
AEIDC	Arctic Environmental Information and Data Center (now ENRI)
AFR	Air Force Regulation
AFS	Air Force Station
AGL	Above Ground Level
AHRS	Alaska Heritage Resource Survey
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interests Lands Conservation Act
ANSI	American National Standards Institute
APTI	ARCO Power Technologies, Inc.
ARS	Alaskan Radar System
BACT	Best Available Control Technologies
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMP	Best Management Practices

BP	Before Present
CB	Citizen Band
CEQ	Council of Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CO	Carbon Monoxide
CVEA	Copper Valley Electric Association
CW	Continuous Wave
DEIS	Draft Environmental Impact Statement
dB	Decibel
DOD	Department of Defense
DOE	Department of Energy
E	Electric Field
EA	Environmental Assessment
EED	Electro-Explosive Device
EFR	Effective Radiated Power
EIS	Environmental Impact Statement
ELF	Extremely Low Frequency
EMD	Electro-Motor Division
ENRI	Environmental and Natural Resources Institute
EPA	Environmental Protection Agency
ETAC	Environmental Technical Applications Center
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FEIS	Final Environmental Impact Statement
FM	Frequency Modulation
FSI	FELEC Services Inc.
GMU	Game Management Unit
GPS	Global Positioning System

GSA	General Services Administration
GVEA	Golden Valley Electric Association
H	Magnetic Field
HAM	Amateur Radio Operator
HAARP	High-frequency Active Auroral Research Program
HCCP	Healy Clean Coal Project
HF	High Frequency
HP	Horsepower
IEEE	Institute of Electrical and Electronics Engineers
IRAC	Interdepartmental Radio Advisory Committee
IRI	Ionospheric Research Instrument
ISR	Incoherent Scatter Radar
ITT	International Telephone and Telegraph
KOP	Key Observation Point
kV	Kilovolts
LIDAR	Light Detection and Ranging
LORAN	Long Range Navigation
M&E/H&N	Metcalf & Eddy, Inc/Holmes & Narver, Inc
MGCI	Master Ground Control Intercept
MHz	Megahertz
MW	Megawatt
MOA	Military Operations Area
MRC	Mission Research Corporation
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center
NEC	Numeric Electromagnetics Code
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act

NOAA	National Oceanic and Atmospheric Administration
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NPS	National Park Service
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NRL	Naval Research Laboratory
NSPS	New Source Performance Standards
NTIA	National Telecommunications and Information Administration
NWS	National Weather Service
OTH-B	Over-The-Horizon Backscatter
PEL	Permissible Exposure Limit
PL	Phillips Laboratory
PM_{10}	Particulate Matter less than 10 microns in diameter
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
RFR	Radio Frequency Radiation
RPM	Revolutions Per Minute
RV	Recreational Vehicle
SAR	Specific Absorption Rate
SHPO	State Historic Preservation Office
SO_2	Sulphur Dioxide
SO_x	Sulphur Oxides
SPCC	Spill Prevention, Containment and Counter-measure
SWDA	Solid Waste Disposal Act
TLV	Threshold Limit Value
TMOA	Temporary Military Operations Area
TSP	Total Suspended Particulates
UAA	University of Alaska Anchorage

UAF	University of Alaska Fairbanks
UHF	Ultra-High Frequency
US	United States
USACOE	U.S. Army Corps of Engineers
USDOC	U.S. Department of Commerce
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
USSCS	U.S. Soil Conservation Service
USSR	Union of Soviet Socialists Republic
VHF	Very High Frequency
VIS	Vertical Incidence Sounder
VOR	VHF Omni-Range
VRM	Visual Resource Management
WACS	White Alice Communication System

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1.0 PURPOSE AND NEED FOR ACTION

1.1 Introduction

The National Environmental Policy Act (NEPA) is the basic national charter for protection of the environment (CEQ, 1978). It states policy and goals and provides the process for carrying out the policy. NEPA procedures were established to ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. To implement NEPA the U.S. Air Force and U.S. Navy have also passed internal regulations that contain policies, responsibilities and procedures (USAF, 1982; USN, 1990). This document, called a Draft Environmental Impact Statement (DEIS), is part of the NEPA process and addresses the consequences of an action on both the natural and man-made environments. The document identifies potential impacts and possible mitigation measures. Based on comments received from agencies, public officials and citizens the document will be revised as necessary to become the Final Environmental Impact Statement (FEIS). The contents of the FEIS will be used by the decision maker to better understand the consequences of the decisions. NEPA regulations direct the document to concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail. Furthermore, it is to be written in a standard format, in plain language and verbose descriptions are to be avoided. Detailed studies and documentation are incorporated by reference rather than in full text. The impact statement is not intended to be a scientific document, the level and extent of detail and analysis in the document should be commensurate with the importance of the environmental issues involved and with the information needs of both decision makers and the general public.

The action proposed in this document would implement a congressionally-initiated program of researching the layer of the earth's atmosphere known as the ionosphere. The proposed research would require the construction of an ionospheric research facility in Alaska. The main part of the research facility would be a large radio wave transmitter. NEPA requires the government to analyze alternatives for their environmental consequences, encourage public input and publish

a Record of Decision. The following schedule gives the approximate dates for the environmental process:

- March 1993, Public Hearing on Environmental Issues
- April 1993, End of Public Comment Period
- July 1993, FEIS Completed
- August 1993, Record of Decision Published

If at the culmination of the NEPA process, the decision is made (as documented in the Record of Decision) to proceed with the project, the tentative schedule is to begin construction in the summer of 1993 and end in the winter of 1996. Once constructed, there would be 4 to 8 full-time jobs available to the local residents for maintenance, technical and security positions.

The remainder of this chapter will discuss the purpose and need for the action, an overview of the planned action, the scope of environmental issues analyzed, and a brief guide to the DEIS. Additional facts on the construction and operation of the facility are discussed in the remainder of the document.

1.2 Purpose

The High-frequency Active Auroral Research Program (HAARP) is a congressionally initiated program jointly managed by the U.S. Air Force and U.S. Navy. The program's goal is to provide a state-of-the-art U.S. owned ionospheric research facility readily accessible to U.S. scientists from universities, the private sector and government. This facility would be the most advanced in the world and would attract international scientists and foster cooperative research efforts. The program's purpose is to provide a research facility to conduct pioneering experiments in ionospheric phenomena. The data obtained from the proposed research would be used to analyze basic ionospheric properties and to assess the potential for developing ionospheric enhancement technology for communications and surveillance purposes.

The layer of the earth's atmosphere called the ionosphere begins approximately 30 miles above the surface and extends upward to approximately 620 miles. In contrast to the layers of the atmosphere closer to the earth, which are composed of neutral atoms and molecules, the ionosphere contains both positively and negatively charged particles known as ions and electrons. These ions and electrons are created naturally by radiation from our sun.

This ionized gas in the ionosphere behaves much differently from the neutral atmosphere closer to the earth. A major difference is that although radio signals pass through the lower atmosphere undistorted, the signals directed through the ionosphere may be distorted, totally reflected or absorbed. For example, communication links from the ground to earth-orbiting satellites can experience fading due to ionospheric distortion; an AM radio signal sometimes can reflect, or "skip", off the ionosphere and be heard at locations hundreds of miles distant from the broadcasting radio station; the characteristic fading on the high-frequency (HF) or "shortwave" band is due to ionospheric interference. Because of its strong interaction with radio waves, the ionosphere also interferes with U.S. Department of Defense (DOD) communications and radar surveillance systems, which depend on sending radio waves from one location to another.

Ionospheric disturbances at high latitudes also can act to induce large currents in electric power grids; these are thought to cause power outages. Understanding of these and other phenomena is important to maintain reliable communication and power services. HAARP is needed to continue and expand basic research efforts on the properties and potential uses of the ionosphere for enhanced communications and surveillance. To meet the project's research objectives, the HAARP facility would utilize powerful, high frequency (HF) transmissions and a variety of associated observational instruments to investigate naturally occurring and artificially induced ionospheric processes that support, enhance or degrade the propagation of radio waves.

Investigations conducted at the HAARP facility are expected to provide significant scientific advancements in understanding the ionosphere. The research facility would be used to understand, simulate and control ionospheric processes that might alter the performance of

communications and surveillance systems. This research would enhance present civilian and DOD capabilities because it would facilitate the development of techniques to mitigate or control ionospheric processes.

Civilian applications from the program's research could lead to improved local and world-wide communication such as satellite communication. Furthermore, and possibly more significant, is the potential for new technology that could be developed from a better understanding of ionospheric processes.

A potential DOD application of the research is to provide communications to submerged submarines. These and many other research applications are expected to greatly enhance present DOD technology.

There are several HF transmitters located throughout the world which conduct research similar to that proposed by HAARP. However, no facility, located either in the U.S. or elsewhere, has the transmitting capability needed to address the broad range of research goals which HAARP proposes to study. The most capable HF transmitters currently operating are located in Russia and Norway and have effective radiated powers (ERP) of roughly one billion watts (1 gigawatt). One gigawatt of ERP represents an important threshold power level, allowing significant radio wave generation and analysis of key ionospheric phenomena. The HAARP facility is designed to have an ERP above one gigawatt. This would elevate the United States to owning and operating the world's most capable ionospheric research instrument.

1.3 Scope of Environmental Analysis

The environmental analysis was conducted and this DEIS was written in accordance with Air Force Regulation 19-2, "Environmental Impact Analysis Process," and the Council on Environmental Quality (CEQ) Regulations, 40 CFR 1500-1508. The scope of the environmental analysis that was conducted and the corresponding scope of this DEIS was limited to the significant issues that were relevant to the decision to be made. Furthermore, scoping meetings

were held in August 1992 to identify major areas of public concern. The concerns of the public as expressed at the scoping meetings are summarized below:

- upgrade of HIPAS (e.g. upgrade vs new facility)
- power requirements (e.g. capability of local power sources)
- gravel (e.g. sources, size of pits, timing and duration, haul routes)
- impact to birds (e.g. collisions with antennas)
- emissions of power generating plant (e.g. coal vs diesel, amounts)
- impact on the local economy (e.g. types and numbers of jobs)
- impact to air space (e.g. restricted zones)
- impact to local recreation (e.g. access, light pollution)
- health effects to humans from radio waves (e.g. cancer, birds flying through the beam, timing of research campaigns)
- interference with communications (e.g. television, local two-way communications, process for handling complaints, notification of operational periods, wildlife telemetry)

Based on the scoping process, these issues and others were consolidated into the following sections:

- Land and Minerals
- Vegetation and Wetlands
- Mammals
- Birds
- Aquatics
- Hydrology and Water Quality
- Air Quality
- Socioeconomics
- Cultural Resources
- Subsistence

- Recreation
- Aesthetics
- Bioeffects of Radio Frequency Radiation (RFR)
- Electromagnetic and Radio Frequency Interference
- Atmosphere
- Threatened and Endangered Species
- Hazardous Materials and Wastes
- Irretrievable Commitment of Resources

The above listed issues were identified based on (1) public comments received through the DEIS scoping process, and (2) topics which would be affected by the construction and operation of the HAARP facility. In this manner, the DEIS was narrowed to only important issues and avoided discussion of issues which were either not of public concern, or would not be affected by HAARP.

1.4 Organization of the DEIS

This DEIS is organized according to the following format:

The Summary provides a synopsis of the information that is in the DEIS: proposed action and alternatives, relevant environmental issues and a synopsis of the environmental consequences. Section 1 is the introduction to the DEIS and describes the purpose of HAARP and the need for the program, the scope of environmental issues addressed in the DEIS, the organization of the DEIS, and the decision to be made. Section 2 details the proposed action, discusses the possible alternatives to the proposed action, and compares the environmental consequences of the alternatives. Sections 3 and 4, respectively, describe the affected environment and the potential environmental consequences of the proposed action and its alternatives. Section 5 provides a list of references cited within the document. Section 6 lists the individuals that contributed to the preparation of the DEIS. Section 7 provides a list of agencies, organizations and persons to whom copies of the DEIS were sent. Section 8 is the subject index for the DEIS.

1.5 Decision to be Made

The decision to be made is whether to build and operate HAARP facilities at the Gakona or the Clear site, or to take no action.

1.6 Permits

The project will require a number of permits and obligations. These are listed and described in Appendix B.

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2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

This section details the proposed action and alternatives to build the HAARP system. Discussion includes background on program work, criteria considered to develop siting alternatives, design alternatives, comparison of environmental consequences of siting alternative, and identification of the preferred alternative.

2.1 CRITERIA USED TO IDENTIFY FEASIBLE ALTERNATIVE SITES

2.1.1 Research Criterion

The goal of HAARP is to provide sufficient energy densities in the polar ionosphere to enable investigations to be conducted on a variety of phenomena triggered by the interactions of high-power radio waves. This goal resulted in the identification of the following criterion for the HAARP facility:

Latitudinal Research Band. Desired polar ionospheric phenomena for investigation occurs under a variety of ambient conditions. These conditions can range from a quiet state with little auroral activity, low magnetic activity index and no polar electrojet to a highly disturbed, rapidly changing aurora, high magnetic index and strong electrojet currents. Such an optimal mix of quiet and disturbed conditions can only be found between approximately 61 and 65 degrees geographic latitude North and South (Dandekar, 1979; Whalen, 1970).

2.1.2 Initial Siting Effort and Background

At the inception of the HAARP program, efforts were made to locate the HAARP facilities in the Fairbanks area to take advantage of the University of Alaska's Poker Flat Rocket Range research facilities. At the time, the University of Alaska was attempting to acquire an expensive piece of scientific equipment (approximately $20 million) which is also required by HAARP. A cooperative agreement between the government and the University of Alaska for this scientific

program was envisioned. The University of Alaska would provide the land on which HAARP would be located, eliminating the need for government land purchase. In an attempt to locate HAARP in the area, the University of Alaska commissioned a study to investigate potential sites in the Poker Flat region (within 33 miles). The study ultimately identified 17 potential sites, with 4 of these sites best meeting land criteria (Roen, 1991).

Since Fairbanks is a large metropolitan area and the region is relatively populated, experiments were conducted in June of 1991 (NRL, 1992a) to determine the potential for electromagnetic interference at the 17 identified sites (Roen, 1991). This study was necessary because significant interference in a large metropolitan area could lead to a prohibitively large and difficult mitigation effort. The study concluded that all of the 17 sites would have a large number of potential radio frequency interference problems (NRL, 1992a). Therefore, all 17 sites were eliminated from further consideration because of the anticipated prohibitively large mitigation effort.

In addition to the 17 sites discussed above, an upgrade of the HF transmitting facility near Fairbanks, Alaska, known as High Power Auroral Stimulation (HIPAS), was considered. The existing HF transmitter at HIPAS has produced some radio frequency interference problems to nearby residences. These interference occurrences for the existing transmitter were resolved with appropriate mitigation techniques. The increased power of the HAARP transmitter located at HIPAS would result in radio frequency interference at considerably greater numbers of residences than currently occurs. This would have required a prohibitively large and difficult mitigation effort. Moreover, the HIPAS site is presently too small to accommodate HAARP facilities. Expansion is not a viable option because the land surrounding HIPAS is privately owned. Consequently, upgrading HIPAS would not provide a suitable alternative.

2.1.3 Final Siting Criteria

After the initial siting efforts at HIPAS and in the region surrounding the Poker Flat Research Range failed to produce a viable site, the search area was expanded. Final siting criteria were

established to aid a search for alternative sites. These siting criteria were developed by considering the requirements for the research facility. The proposed research facility would be composed of several structures of varying sizes each with specific requirements on separation from the IRI. The criteria, listed below, are briefly explained in the sections which follow.

First Level

- Within U.S. borders
- Using DOD owned land to the greatest extent practical

Second Level

- Near a primary highway
- Away from urban areas
- Suitable land area and collocation ability
- Relatively flat terrain
- Realistic and reasonable

Within U.S. Borders. The HAARP research facility must be located on U.S. soil which provides access to the polar ionosphere. The state of Alaska is the only United States property which offers access to the polar ionosphere which HAARP proposes to study (Figure 2.1.1).

Using DOD Owned Land to the Greatest Extent Practical. The HAARP facility should be located on land currently owned by the DOD to the greatest extent practical for a number of reasons. First, it is good management practice to use resources currently available when possible. This saves both time and money. Second, using DOD owned land would be compatible with current Air Force Policy. Air Force Regulation (AFR) 87-1 provides guidance on acquiring property for Air Force use and requires that the Air Force lease or purchase land only as a last resort after all other methods of fulfilling the need have been deemed unfeasible. Third, it is desirable to locate the HAARP facility on DOD owned land to preclude further DOD acquisition of land in Alaska since the DOD already owns a substantial amount of Alaskan real estate. Finally, the DOD has issued a moratorium on major land acquisitions which states that

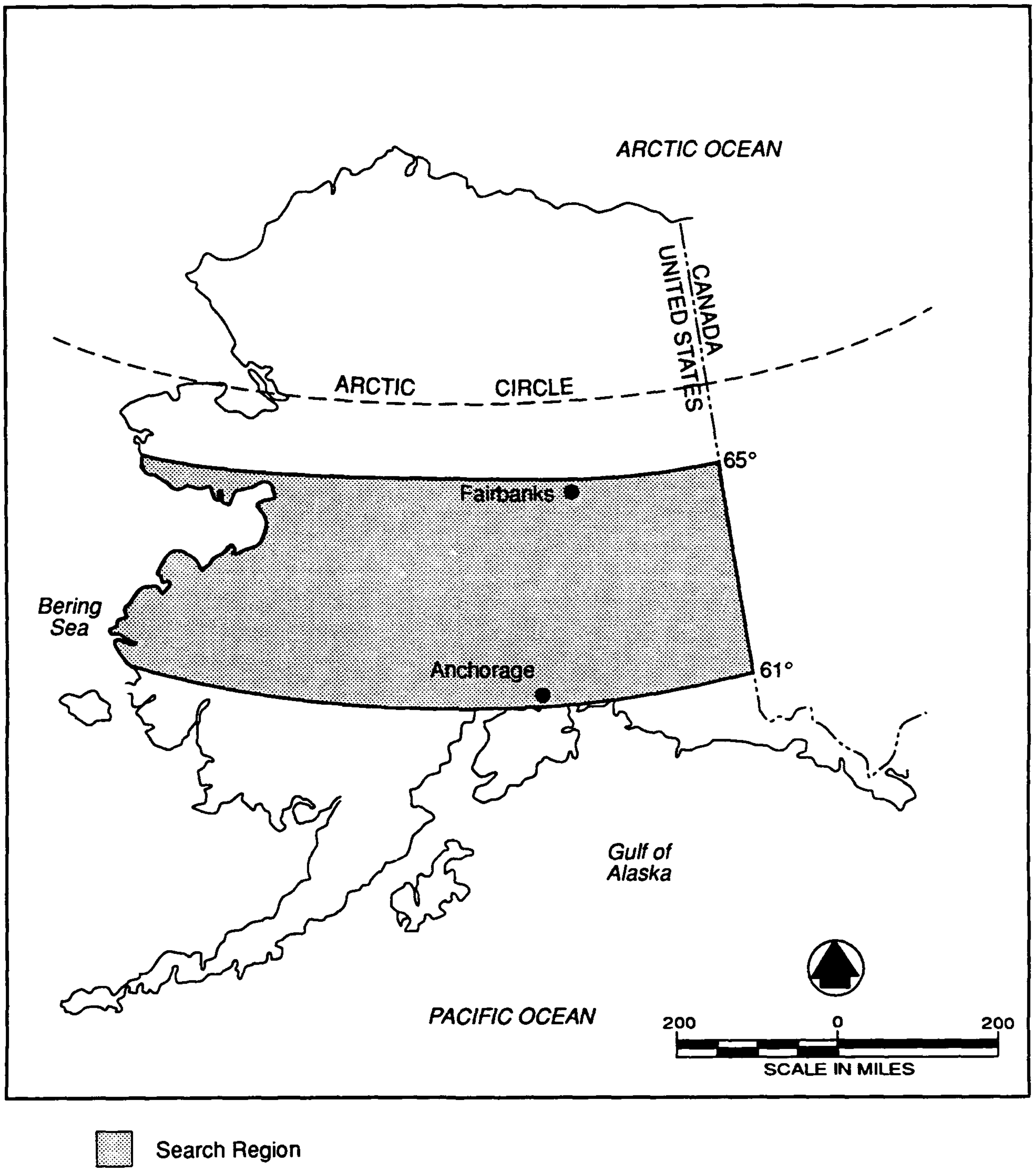


FIGURE 2.1-1. HAARP LATITUDINAL RESEARCH BAND IN ALASKA

the DOD should "propose the acquisition of land only where there is a clearly demonstrated need" (DOD, 1990a; DOD, 1990b). The DOD has defined major land acquisitions as "those involving more than 1,000 acres, or land whose estimated purchase price or annual lease price exceeds $1 million". Although the land needed for HAARP might not qualify as a "major land acquisition", it is clear that HAARP should comply with the spirit of the moratorium and attempt to locate the facility on DOD land before acquiring private land for the program (USAF, 1992a).

Near a Primary Highway. The HAARP facility should be located within a reasonable distance (about 10 miles) of a primary highway for logistical reasons and to limit construction, operation and environmental costs. For the purposes of this discussion, a primary highway is defined as a paved state or federal highway which remains open and functioning throughout the year.

Avoiding Densely Settled Areas. The HAARP facility would include active and passive optical and radio wave sensors. The HAARP facility should be located so as to avoid densely settled areas in order to ensure the proper operations of the research facility. The diagnostic instrumentation requires fairly stringent ambient conditions to function properly. First, the passive radio wave diagnostics should be located away from diverse man-made radio wave noise sources that could interfere with the functioning of sensitive receivers. Second, optical diagnostics must be located away from artificial light sources. Nearby urban illumination of middle and cirrus clouds, lower altitude atmospheric dust and/or particulate pollutants could obscure atmospheric and/or ionospheric emissions.

Densely settled areas would also contain numerous radio frequency receivers that would experience interference from the ionospheric research instrument (IRI). Mitigation for such a large number of problems would be prohibitively difficult. Avoidance of such areas would eliminate the need for prohibitively extensive mitigation.

Collocation and Sufficient Land Area. The proper collocation of the IRI and the associated diagnostic equipment is critical to the operation of the program. Most of the diagnostic equipment need certain separation distances from the IRI and other facilities. For example, the

incoherent scatter radar (ISR) must be located between about 2 to 10 miles from the IRI. The vertical incidence sounder (VIS), optical imager and magnetometer, and light detection and ranging (LIDAR) also have inter-related separation requirements.

The HAARP facility would require a "footprint" area of approximately 50 acres of land to accommodate the IRI and the diagnostic equipment. However, considerably more land would be required to accommodate the necessary separation distances between the IRI and diagnostic equipment. These separation distances are essential for the proper operation of the HAARP equipment. The actual amount of total acreage would vary depending upon the parcel shape. While use of one parcel for the entire facility would be the most desirable, if necessary, some of the equipment requiring large separation distances from the IRI could be located on a different parcel. In such a situation, the parcels collectively would constitute one HAARP site.

Relatively Flat Terrain. The HAARP facility should be located on land which does not exceed a slope of approximately two percent (vertical/horizontal). The antenna array requires a reasonably level plain in order to function properly. From a construction and engineering perspective, the HAARP facility would become unreasonably and prohibitively expensive to construct on a slope exceeding about two percent.

Realistic and Reasonable. The CEQ requires that only realistic and reasonable alternatives be considered in detail.

2.2 ALTERNATIVES INITIALLY CONSIDERED

2.2.1 Alternative Sites

Alternative sites initially considered for the HAARP program were evaluated against the first level criteria of within the U.S. borders and on DOD owned land. These sites included 7 military installations or reservations, 8 sites identified by the Corps of Engineers, and 5 previously identified sites considered in the Over-the-Horizon Backscatter (OTH-B) Environmental Impact Assessment Process for the Alaska Radar System. Of these, the only sites meeting the first level criteria were 7 military reservations and one of the OTH-B sites. They are:

- Elmendorf Air Force Base
- Fort Richardson
- Eielson Air Force Base
- Clear Air Force Station
- Fort Greely
- Fort Wainwright
- Fort Wainwright Military Reservation
- Gulkana

2.2.2 Comparison Of The Second Level Criteria and Alternative Sites

The comparison of the alternative sites with the siting criteria is presented in Table 2.2-1. Elmendorf Air Force Base (AFB), Fort Richardson, Eielson AFB and Fort Wainwright were eliminated from consideration because they would be too close to densely settled areas and the associated large numbers of radio frequency receivers. Elmendorf AFB and Fort Richardson are in Anchorage, Alaska; Fort Wainwright is just outside of Fairbanks, Alaska; and Eielson AFB is approximately 20 miles south of Fairbanks and just outside of North Pole, Alaska which

TABLE 2.2-1. COMPARISON OF SECOND LEVEL SITING CRITERIA AND ALTERNATIVE SITES

Sites	Near Primary Highway	Avoid Densely Settled Areas	Collocation and Sufficient Space	Relatively Flat Terrain	Realistic & Reasonable
Elmendorf AFB	•	x	•	•	•
Fort Richardson	•	x	•	•	•
Eielson AFB	•	x	•	•	•
Clear AFS	•	•	•	•	•
Fort Greely	•	•	•	•	•
Fort Wainwright	•	x	•	•	•
Ft. Wainwright Military Reserv.	•	•	•	•	x
Gakona (Gulkana)	•	•	•	•	•

LEGEND

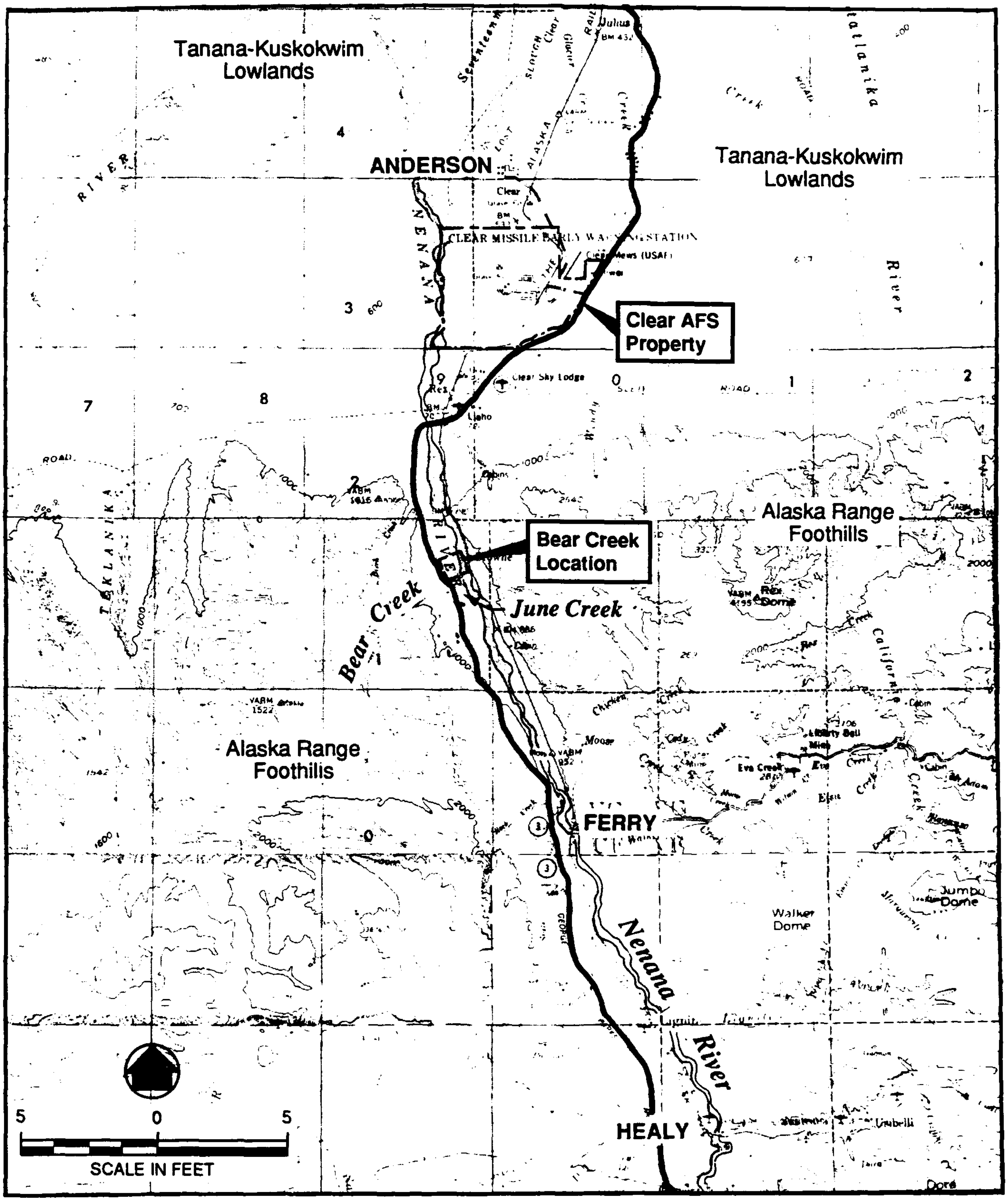
- • Site Complies with Criterion
- x Site Does Not Comply with Criterion
- (shaded) Site Complies with All Criteria

is a suburb of Fairbanks. Reliable surface access to Fort Wainwright Military Reservation would require a long-span bridge (roughly 2,500 feet long), at a projected cost of tens of millions dollars, to span the Tanana River. Consequently, use of Fort Wainwright Military Reservation was deemed unrealistic and unreasonable and it was dropped from further consideration.

The remaining military reservations, Clear Air Force Station (AFS) and Fort Greely, meet all the criteria established for the HAARP Program. Gulkana, originally selected for siting the OTH-B transmitter facility also meets all the criteria. To circumvent possible confusion between the OTH-B Program and the HAARP Program, it was decided to rename the Gulkana site after the nearest settlement Gakona. From this point forward in the document, this site will be referred to as Gakona.

Subsequent to the identification of the 3 potential alternatives, discussions were held with responsible officials of each site to consider any overlying issue that could lead to conflicts and unreasonable delays. The Ballistic Missile Early Warning System (BMEWS) radar operating at Clear AFS was identified as a possible conflict with the most critical HAARP diagnostic equipment. The BMEWS radar system employs powerful radars that operate within the 400 - 450 MHz band which includes the 430 - 450 MHz band, one of the bands proposed for the on-site diagnostics for the HAARP facility. The government commissioned an electromagnetic compatibility study to determine if a feasible option was available to allow the co-existence of the BMEWS radars and the HAARP facility (MITRE, 1992a). This study concluded that the more powerful BMEWS radars would conflict with the ISR diagnostic operation since the two operate on adjacent frequencies. It was determined, however, the Clear AFS could be used if the ISR was located in an area where a major land form (i.e. mountain, hill, ridge, etc) exists between it and the BMEWS radar thereby providing an electromagnetic barrier. A site (called the Bear Creek location) in the foothills of the Alaska Range in the Nenana River Valley slightly north of Bear Creek was identified as a suitable location for the ISR. This location was selected because it is within the maximum allowable separation distance from the IRI, and because a 400-foot high ridge exists between this location and the BMEWS radar which provides a natural electromagnetic barrier that would be effective in isolating the ISR from the BMEWS (Figure 2.2-1). This siting approach is consistent with the criterion of using DOD owned land to the greatest extent practical since the majority of the facility would be located on DOD owned land.

Fort Greely is an U.S. Army post and training area located in the Delta Junction Area of Alaska. The U.S. Army felt that HAARP would constitute a non-compatible land use with current U.S. Army operations (US Army, 1992). To avoid unnecessary delay due to non-compatible activities, Fort Greely was dropped from consideration as an alternative.



SOURCE: USGS Fairbanks, Alaska 1976

FIGURE 2.2-1. TOPOGRAPHY IN THE CLEAR REGION

The Gakona site became available when OTH-B Alaskan Radar System was terminated. If no alternate use of the existing OTH-B structures is identified then the structures at the site will be demolished. No conflicting issue at Gakona was identified that could lead to undue delays. Thus, Clear AFS and Gakona will be evaluated in detail as reasonable alternative sites (Figure 2.2-2).

2.2.3 Alternative Designs

In addition to upgrading existing facilities and searching for alternative siting areas, alternative designs were also considered that could achieve HAARP program goals. A request for proposals (RFP) was issued for the design of the Ionospheric Research Instrument (IRI), the central component of the HAARP program. Two alternative designs for the IRI, a stacked array and a dual array, were proposed (APTI, 1992). Both designs meet the criterion for providing the transmitting capability necessary for the HAARP Program. Both designs require the same operations center, power to operate, and on-site and off-site diagnostic equipment.

Stacked Array. The IRI would consist of 180 crossed dipole antenna elements arranged in a grid pattern of 12 rows and 15 columns (Figure 2.2-3). The proposed design for the stacked IRI calls for the low frequency antenna to be stacked above the high frequency antennas (Figure 2.2-4). The elements would be supported on 66-foot masts mounted on steel base piles extending 4 feet above the ground and spaced at 80-foot intervals.

The low frequency element is approximately 69 feet long and 52 feet above the ground (Figure 2.2-5), and transmits 3.2 MW of energy in a frequency range of 2.8 - 7.6 MHz. The high frequency element is approximately 55 feet long and 45 feet above the ground and transmits 3.2 MW of energy in a frequency range of 7.3 - 10.0 MHz.

The masts would be guyed at the top and midpoints and anchored to the base piles of the adjacent masts. A suspended ground screen would run throughout the antenna grid area at a height 15 feet above the ground and would extend 40 feet beyond the perimeter antenna masts.

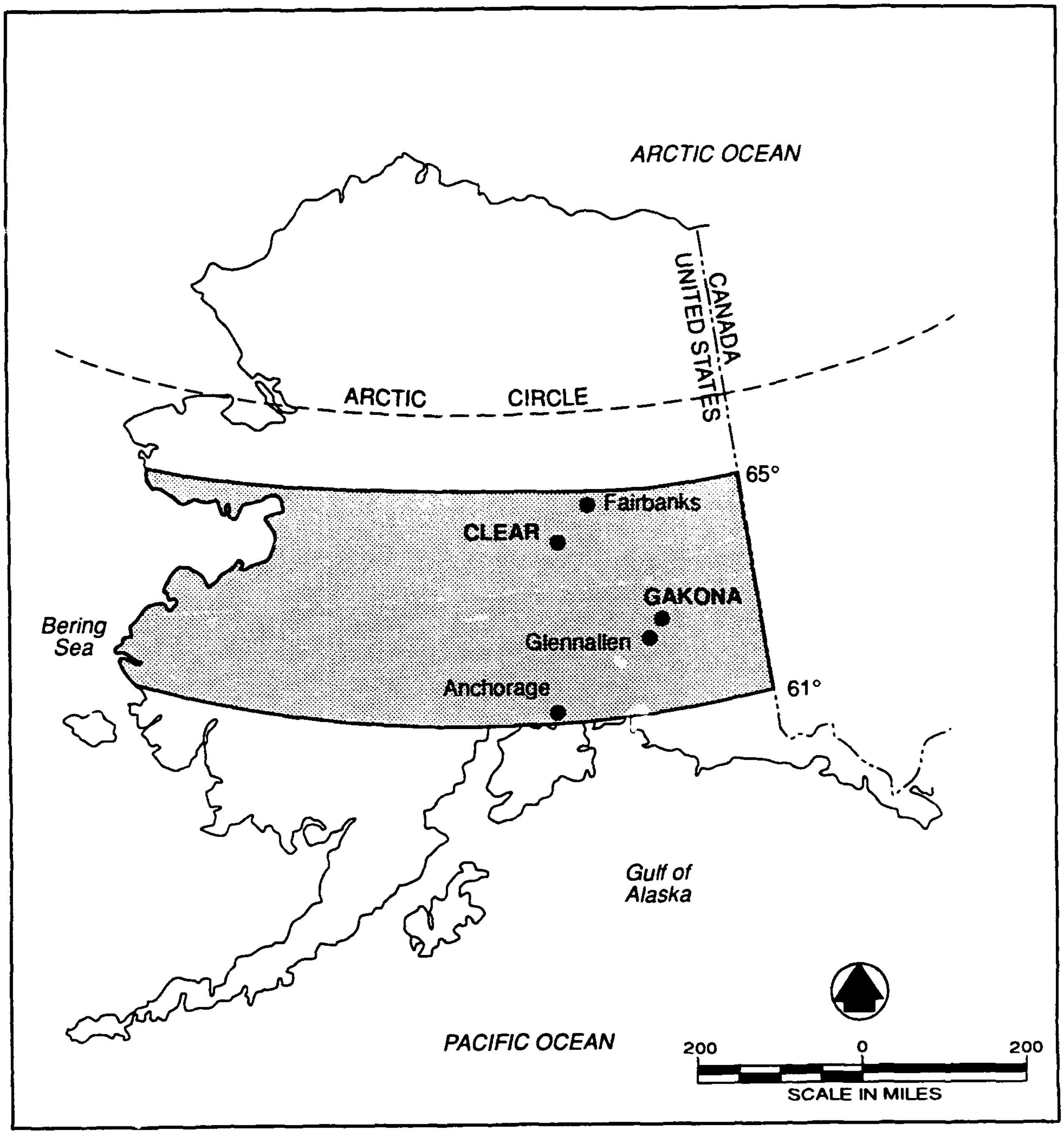
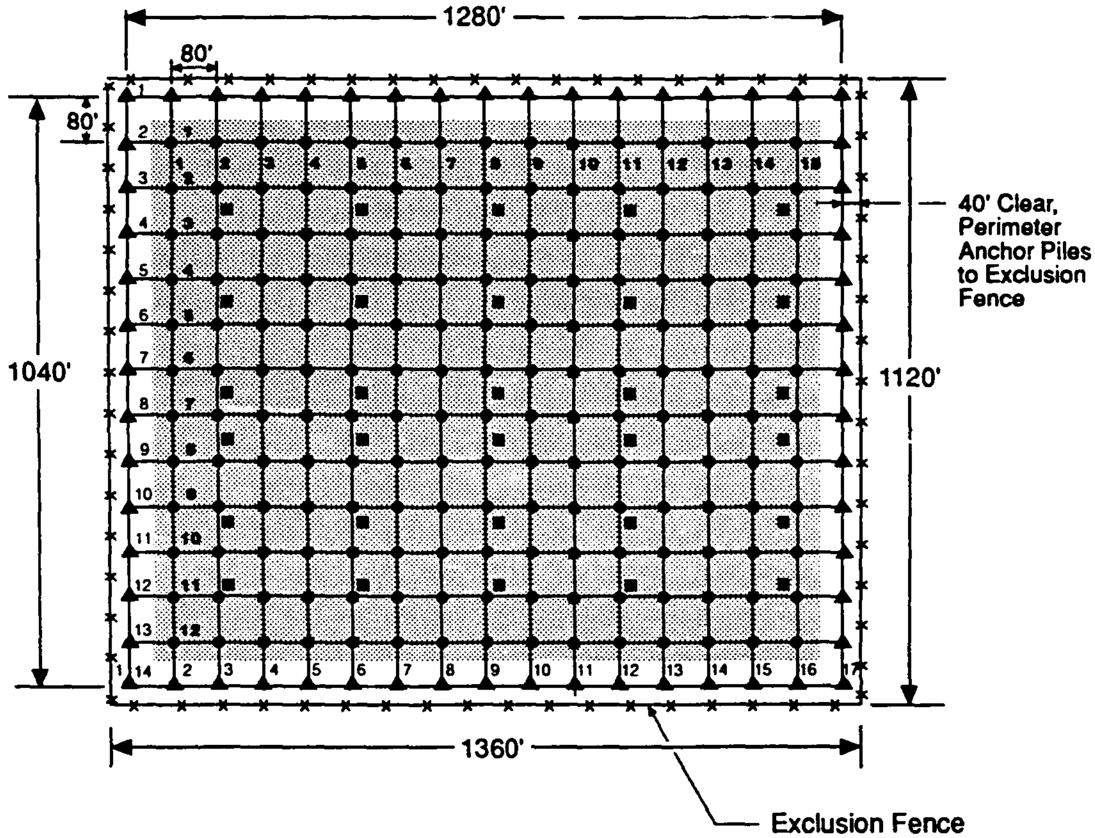


FIGURE 2.2-2. GAKONA AND CLEAR, ALASKA SITES



LEGEND

- ● Base Piles/Antenna Masts (180 Units)
- ▲ Anchor Piles (58 Units)
- ■ Transmitter Modules (30 Units)
- ▒ Ground Screen

NOT TO SCALE

FIGURE 2.2-3. STACKED IRI ANTENNA FIELD LAYOUT

dl/2817-2 6S/GE

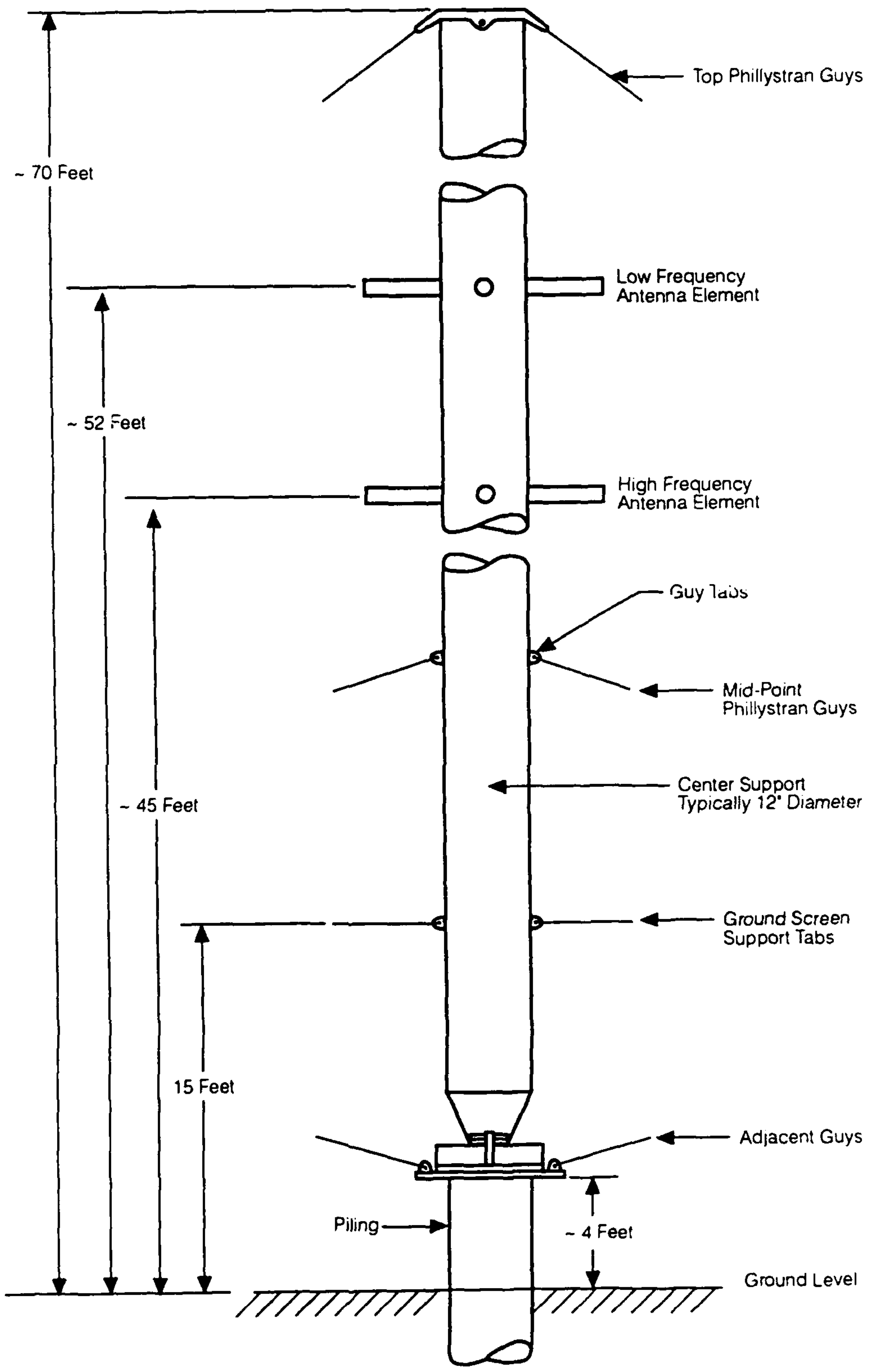
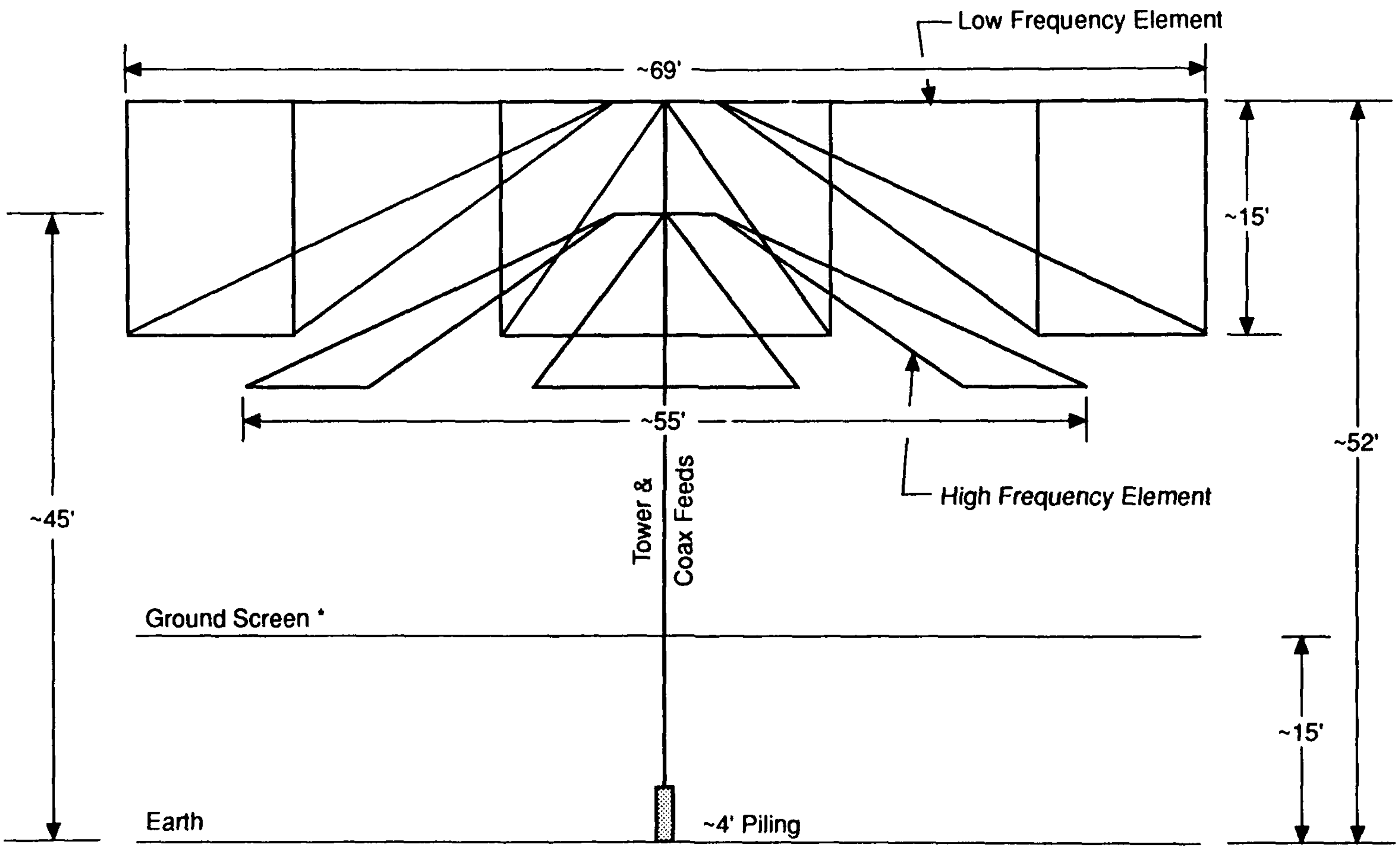


FIGURE 2.2-4. STACKED ARRAY SUPPORT MASTS



*Note: Continuous Under Array. Extends Approx. 40' Beyond Perimeter Masts

FIGURE 2.2-5. SIDE VIEW OF PROPOSED STACKED IRI ANTENNA ELEMENT

2817JI-2.

The mesh of the screen would be not greater than 3 feet square. Fifty-eight additional piles would be required around the perimeter of the antenna grid to support the groundscreen extension and to act as antenna mast tie-down anchors. This entire array system would occupy a foot print approximately 1040 feet x 1280 feet. The IRI antenna field would be enclosed by a fence restricting access to a total area of 1,120 feet by 1,360 feet, or 35 acres.

Thirty shelter modules would be distributed evenly along 5 of the mast support columns within the antenna grid. These modules would house transmitting equipment used to power the individual antenna elements. All shelter modules would be approximately 38 feet long by 8 feet wide by 10 feet high supported by a skid frame set on a post-and-pad or pile foundation.

Dual Array. In contrast to the stacked array in which the high and low frequency antennas are stacked upon each other, the dual array design would be comprised of two adjacent antenna arrays fields. One antenna field would consist of the high-frequency antennas and the adjacent array would be comprised of the low-frequency antennas (Figure 2.2-6).

The high frequency array would consist of 210 crossed dipole antenna elements arranged in a grid pattern of 14 rows and 15 columns. The elements would be supported on 60-foot high masts mounted on steel base piles extending 4 feet above ground and spaced at 77 feet intervals. Each mast would support a high frequency element approximately 42 feet in length, supported on masts at a height approximately 46 feet above the ground (Figure 2.2-7) and would transmit 3.3 MW of energy at a frequency range of 6.0 - 10.0 MHz.

The masts will be guyed at the top and midpoints and anchored to the base piles of four adjacent antennas. A suspended groundscreen (mesh size 3 feet square) would run throughout the high frequency antenna grid area at a height 15 feet above the ground and would extend 38.5 feet beyond the perimeter antenna masts. Sixty-two additional base piles would be required around the perimeter of the antenna grid to support the groundscreen extension and to act as antenna mast tie-down anchors. The entire high frequency array system would occupy a footprint approximately 1078 feet x 1232 feet (Figure 2.2-6).

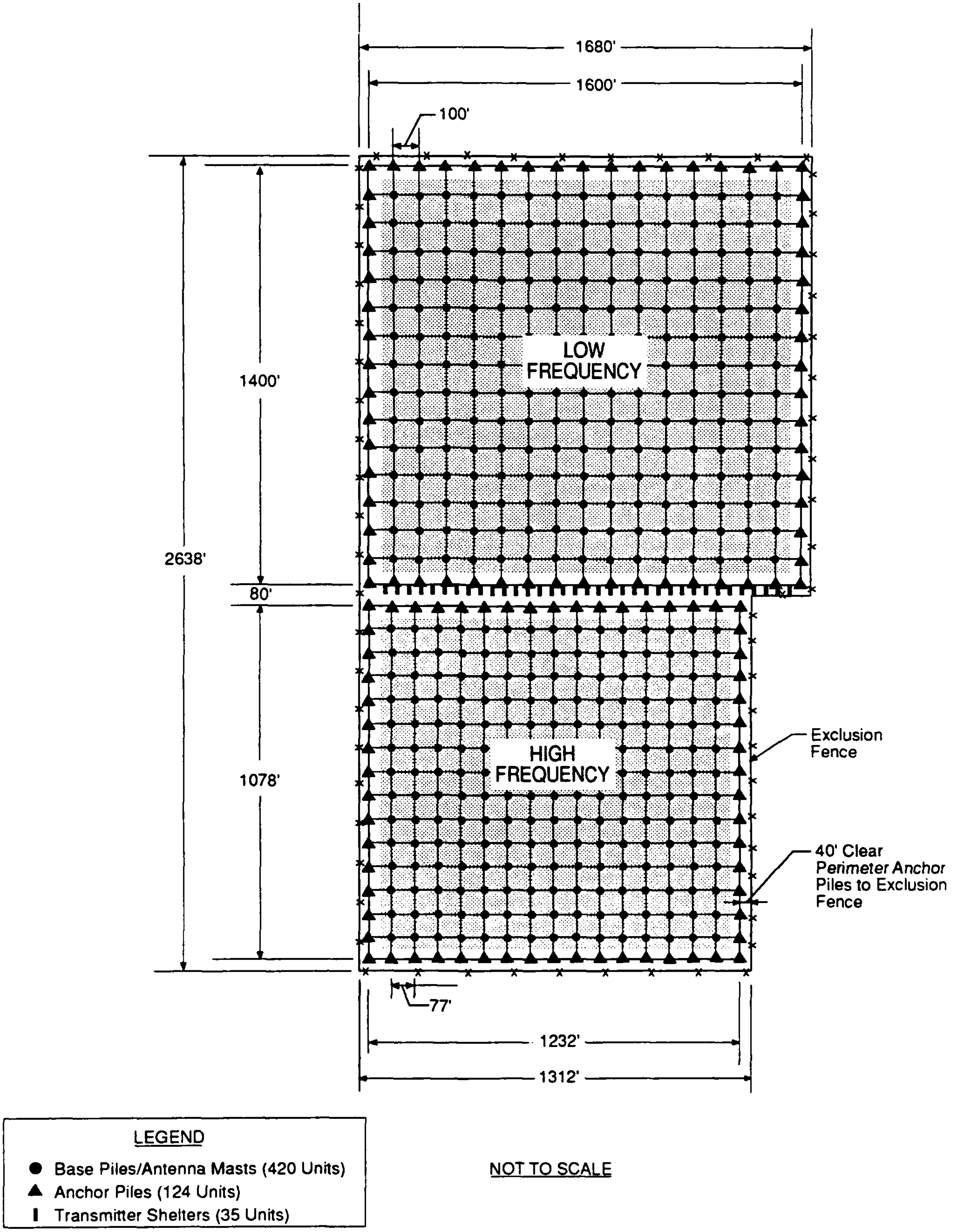
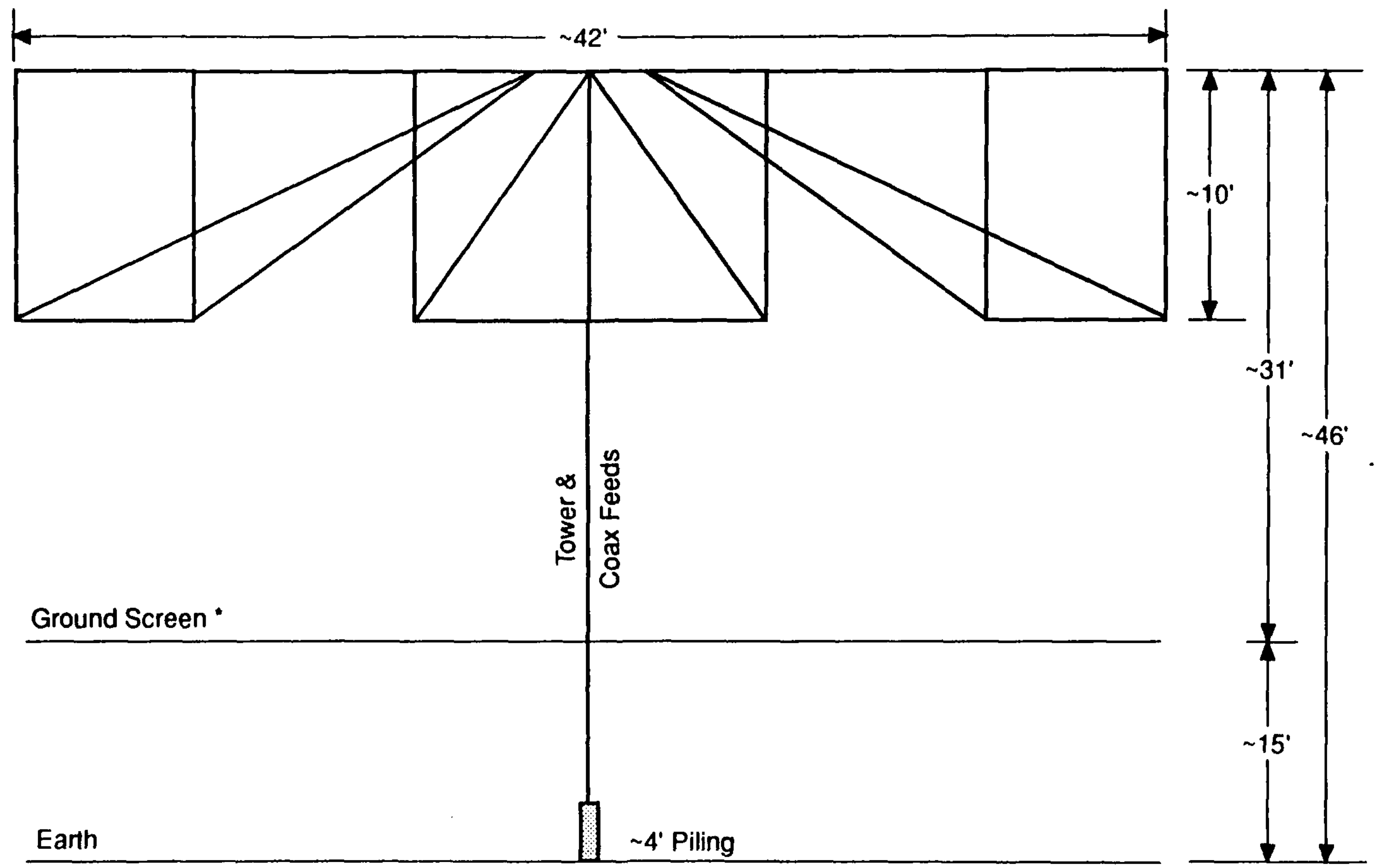


FIGURE 2.2-6. DUAL ARRAY FIELD LAYOUT



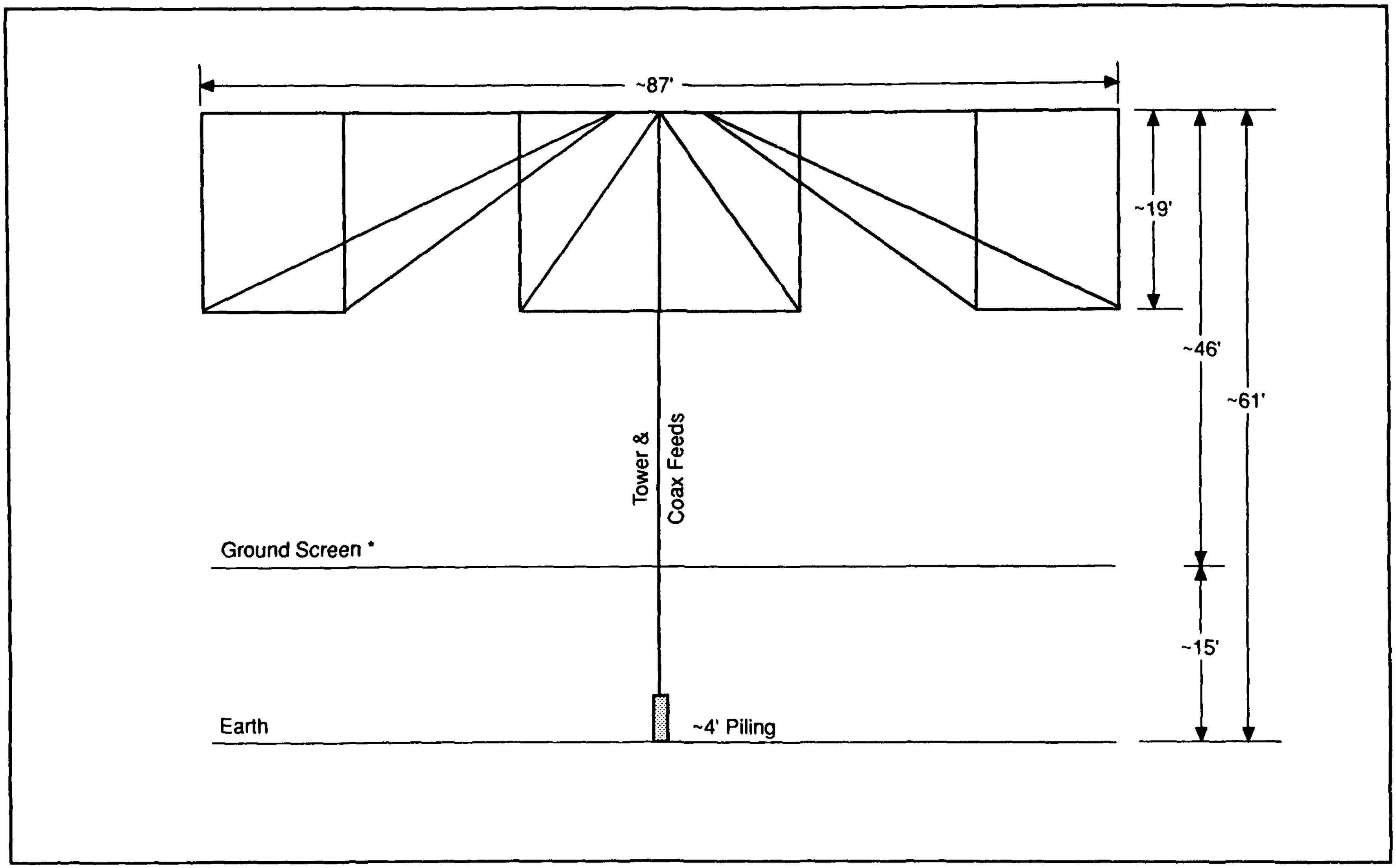
*Note: Continuous Under Array. Extends Approx. 40' Beyond Perimeter Masts

FIGURE 2.2-7. HIGH FREQUENCY DUAL ARRAY ELEMENT

The low frequency array is very similar to the high frequency array and is illustrated in Figure 2.2-8. The major differences evident in the low frequency array are that the low frequency array has larger overall dimensions and has longer and higher individual antenna elements than the high frequency array (Figure 2.2-6). This array system also would consist of a 14 row by 15 column grid arrangement of crossed dipole antenna elements as before however the support masts are 80 feet high and are spaced at 100-foot intervals. Each mast would support a low frequency element approximately 87 feet in length, supported on masts at a height approximately 61 feet above the ground (Figure 2.2-8) and would transmit 3.2 MW of energy at a frequency range of 2.8-6.0 MHz.

The masts would be guyed at the top and midpoints and anchored to the base piles of four adjacent antenna as illustrated in Figure 2.2-8. A suspended groundscreen would run throughout the low frequency antenna grid area at a height 15 feet above the ground and would extend 50 feet beyond the perimeter antenna masts. Sixty-two additional base piles would be required around the perimeter of the antenna grid to support the groundscreen extension and to act as antenna mast tie-down anchors. The entire low frequency array system would occupy a footprint approximately 1600 feet x 1400 feet (Figure 2.2-6). Thirty-five shelter modules would be distributed evenly along the site access road between the two array fields. These modules would house transmitting equipment used to power the individual antenna elements. In addition, a "master control module" would be located at the middle of the group. All shelter modules would be approximately 38 feet long by 8 feet wide by 10 feet high supported by a skid frame set on a post-and-pad or pile foundation. The dual array would be enclosed by a fence providing a 40-foot clear zone from the perimeter anchor piles, around each of the arrays (Figure 2.2-6). The total enclosed area is approximately 90 acres.

Comparison of Stacked and Dual Designs. When comparing the stacked array and the dual array, it is readily apparent that the dual array would require more than twice the area and twice the number of masts and associated equipment to support the IRI antenna elements. The dual array would require approximately twice the gravel to be excavated and placed at the site as



*Note: Continuous Under Array. Extends Approx. 50' Beyond Perimeter Masts

FIGURE 2.2-8. LOW FREQUENCY DUAL ARRAY ELEMENT

compared to the stacked array, for a given site. Furthermore, the dual array would disturb about twice the amount of vegetation as would the stacked array. The dual array will not be considered further because of its obvious, considerably greater environmental and financial costs as compared to the stacked array. Thus, only the stacked array will be considered in the remainder of this EIS.

2.3 ALTERNATIVES IDENTIFIED FOR FURTHER ANALYSIS

Three categories of alternatives were considered toward achieving HAARP Program goals: upgrade of an existing facility; consideration of alternative sites; and, considering alternative IRI designs. Each category was considered in detail, based on set criteria, to determine reasonable alternatives for further analysis. From the many alternatives considered, three alternatives were identified for further analysis: construct the stacked array HAARP facility at the Gakona site; construct the stacked array HAARP facility at the Clear site; and, the no action alternative. Both the Clear site alternative and the no action alternative would include the reclamation of the Gakona site. The government recognizes that they are obliged to implement a near-term reclamation effort at either the Gakona or Clear site at the termination of the program or when no other use of the proposed HAARP facility has been identified.

2.3.1 Preferred Alternative - Gakona

The proposed Gakona, Alaska, site (Figure 2.2-1) was previously designated by the Air Force as the location for the OTH-B ARS transmit site. Facilities at the Gakona site, constructed as part of the OTH-B Program, include an approximately one mile long access road leading from the Tok Cut-Off Highway, and a large previously constructed metal building once needed to house the OTH-B powerplant. This building covers an area approximately 21,000 square feet in size and is erected on a mechanically refrigerated foundation slab, placed in a large gravel pad adjacent to the existing site access road. The ARS portion of the OTH-B Program was terminated in 1991 by the Air Force and the Gakona site has remained under the ownership of the Air Force. The facilities are now available for other appropriate government use such as HAARP.

IRI and Support Facilities. The IRI would be located at the end of the existing site access road along the southern edge (Figure 2.3-1). This location for the IRI was chosen based on the goal of minimizing wetland fill, using existing assets and minimizing financial costs. The installation of the IRI would require the placement of approximately 95,000 cubic yards of fill material.

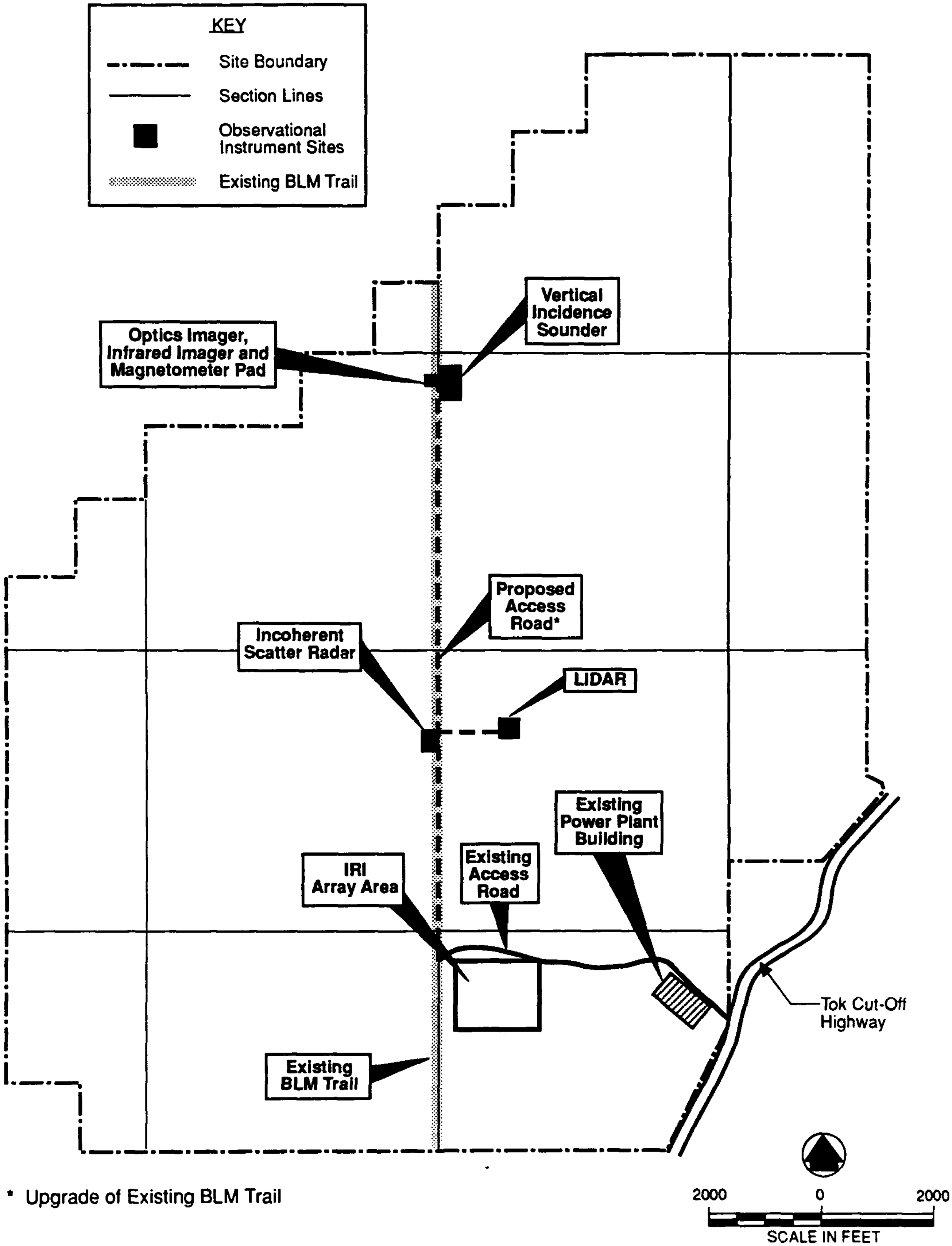


FIGURE 2.3-1. PROPOSED FACILITY LAYOUT AT GAKONA SITE

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The fill would be placed in 17 parallel strips (corresponding to the number of columns described in the description of the stacked array above) extending south from the existing access road. Twelve of the strips of fill would be approximately 1000-foot long, 20 feet wide, 5 feet in depth and have nominally 3 to 1 side slopes. Five, so called center strips, would be intermixed with the other 12 and would be similar in design, except they would have a 50-foot top-width. These 5 strips of extra width would accommodate the 30 transmitter modules (6/strip). The 17 graveled strips would be spaced on 80 feet centers and would allow for the protection of the marginal permafrost during year-round construction and operation of the IRI. Each strip would have base and/or anchor piles installed in it and a minimally sized service road along the top. Additionally, 2 closing roads would be constructed (approximately 1300 feet each) at the ends of, and perpendicular to, the parallel strips. The closing roads would be similar in design to the 20-foot wide road.

Operations Center. The operations center would be located in an enclosed area 54 feet wide by 165 feet long which is a portion of the existing OTH-B powerplant building. The operations center would include the following: a site entry control point, an office and shop for site maintenance, supply and storage areas for site support, the IRI control room, a conference area, a break room, restrooms (including showers), an instrument control room for the diagnostic equipment, mechanical and electrical utility rooms, three offices for research scientists, rest quarters for eight people, water storage for fire protection and domestic uses, a wastewater holding tank, and a communications system.

Site Power Requirements and Sources. The HAARP facility would utilize two primary power sources. Electrical power for the actual operation of the IRI and the main diagnostic equipment would be provided by a large, on-site diesel generator facility discussed below. Electrical power for maintenance of on-site facilities and the operation of on-site diagnostic equipment would be provided from a commercial off-site source. The necessary commercial power requirements would be met through an upgrade of the existing Copper Valley Electric Association (CVEA) power line which runs by the Gakona site, as discussed below. Two small on-site backup diesel generators would provide emergency power for the needs of the generator/operations building

in the event of the loss of commercial power. There would be no emergency backup power source for the IRI, ISR and on-site diagnostics.

On-Site Power Generation. The large on-site diesel generators would be located in a 95-foot by 126-foot portion of the existing OTH-B powerplant building (Figure 2.3-1). The six generators are to be driven by Electro-Motor Division (EMD) diesel engines. The diesel engines are rated at 3600 horsepower (HP) at 900 revolutions per minute (RPM). The generators are three-phase synchronous generators that would be capable of providing a maximum of 15 MW (6 @ 2.5 MW each) of operational power to the IRI and ISR. Terminal output voltage is 12.47 kilovolts (kv). External radiators, mounted on the roof, would be installed to cool the engines. Final exhaust stack heights will be determined during the future design phase of this facility and would be in compliance with all applicable state and federal regulations.

Off-Site Power, Commercial Line Upgrade. The CVEA would upgrade the existing "North Line" from single phase to three phases (Figure 2.3-2). The line to be upgraded would begin at milepost 126 on the Richardson Highway, proceed along the highway heading north, cross the Gulkana River, pass by the Gulkana Village, and continue to mile post 130.5 where the section leading to the Gakona community branches off to the east. The three-phase upgrade would continue on the Gakona community line through Gakona and would follow the Tok Cutoff to the site. The upgraded section would be above ground to the site access point. At the site a buried line would connect the main line to a substation.

Substation. A two part substation would be located within the existing powerplant building. One part would handle the on-site produced 12.47 kv power from the diesel generators. The second part would handle the stepdown of commercial 24.9 kv power to the required 12.47 kv. Dual, three phase, distribution feeders would leave the substation and follow the site access and trail roads to provide electrical power to the various HAARP equipment items and supporting facilities.

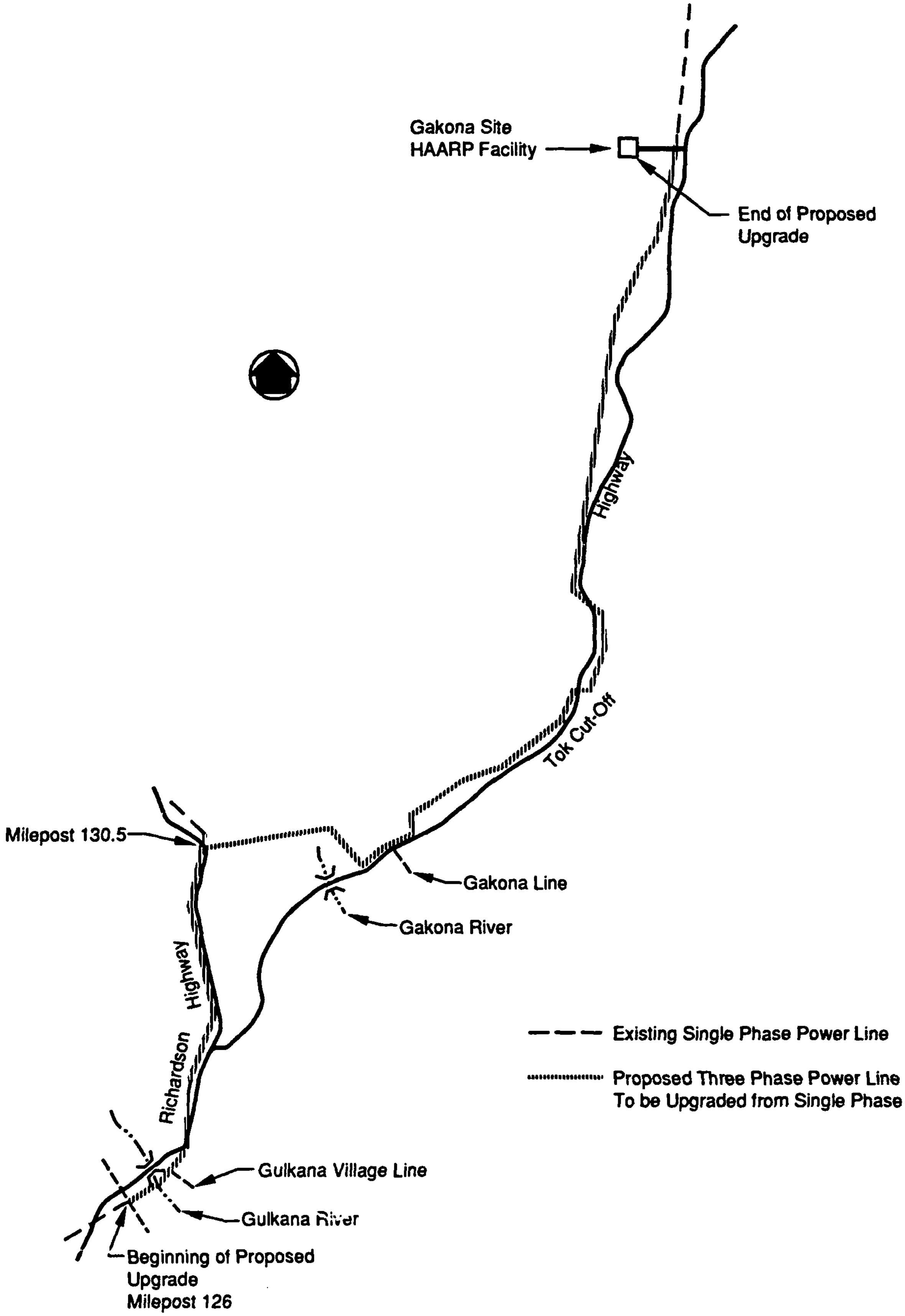

FIGURE 2.3-2. PROPOSED POWER LINE UPGRADE

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Fuel Storage & Delivery. A fuel delivery and storage system would be located adjacent to the operations/generator building. Fuel consumption for an average research campaign would be approximately 200,000 gallons. This assumes an average research campaign of 10 preparation days, 14 experiment days, and 4 shutdown days. Four to five campaigns per year are anticipated, although additional campaigns could be accommodated if necessary. An additional 2900 gallons of fuel would be consumed each year for system checks. The diesel plant's fuel storage facilities are estimated to be capable of storing 200,000 gallons of fuel. Four 50,000-gallon above-ground fuel storage tanks would be located at the site to accomplish this. A fuel unloading area would also be provided to enable the safe off-loading of fuel oil delivered. The delivery and storage system will be constructed in compliance with all applicable safety and environmental standards.

On-Site Diagnostic Equipment. The following diagnostics would be collocated on the Gakona site: Incoherent Scatter Radar (ISR), high frequency (HF) sounder, infrared imager, optical imager, magnetometer and LIDAR. A description of each, including site specific details, are provided below. Access to these diagnostics at Gakona would require extending the present 40-foot wide site access road approximately 300 feet to the point where it intersects an existing trail and cutline running north/south through the site. This trail would be improved with gravel, becoming 12 to 16 feet in width and extending north from the intersection some 9,500 feet to the furthest diagnostic (Figure 2.3-1). Data, power and communication lines would be buried or run above surface along the existing access road and the new north/south trail road. Each of the diagnostic areas would be enclosed in a fence for security and safety reasons.

Incoherent Scatter Radar (ISR). The purpose of the ISR is to study ionospheric electron density variations with altitude, temperatures, and motions, as well as other parameters of the ionosphere. The ISR is considered a principal diagnostic because it can provide detailed data on background ionospheric conditions and changes. The ISR would consist of a large radar dish approximately 115 feet in diameter. The dish antenna would be supported by a 25-foot diameter support structure, approximately 35 feet above the ground. In addition,

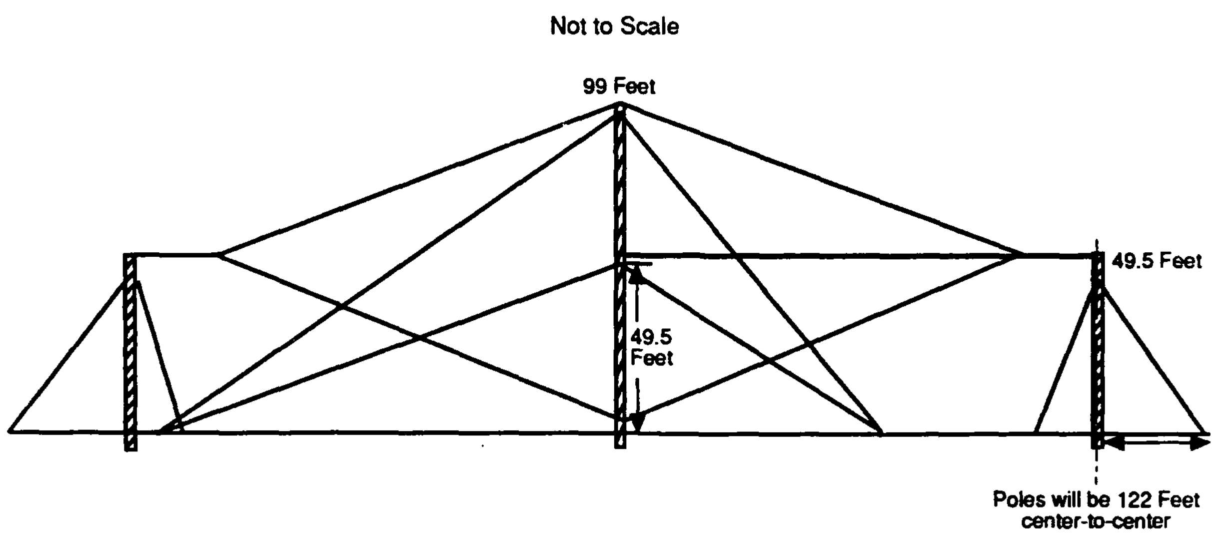
a trailer module would be located adjacent to the support structure to house the control equipment.

The ISR would be located 4000 feet north of the IRI, along the north/south trail road on a presently uncleared portion of the site. The cleared area required for the construction of this diagnostic is approximately 200 feet by 200 feet containing a gravel pad 160 feet by 160 feet in size.

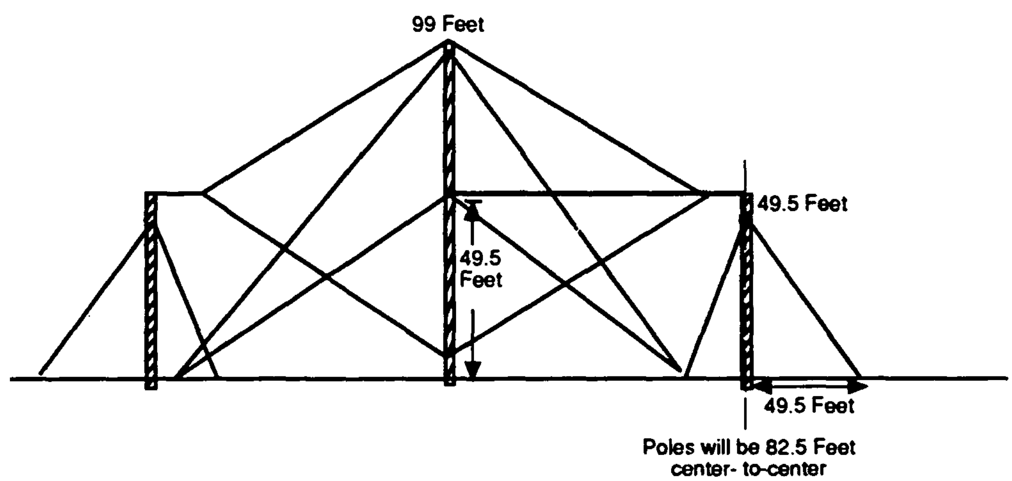
Vertical Incidence Sounder (VIS). The VIS would be used to determine the location and movement of large scale ionospheric structures. The data from the VIS would also be used to determine the operating modes for the IRI. The diagnostic would include both a transmitter and receiver. The transmitter would consist of two dipole antenna elements supported by five masts (Figures 2.3-3). The center masts would be approximately 100 feet tall and the four perimeter masts would be approximately 50 feet in height. The total pad size for the transmitter array is approximately 250 feet square. All of the masts and antenna elements would be guyed to the ground as indicated in Figure 2.3-3. The receiver array would consist of three elements arranged in a triangular configuration with a fourth element in the center of the triangle. Each of the elements would be approximately 4 to 5 feet high and mounted on steel plates. The total pad size for the receiver array is approximately 210 feet square.

At the Gakona site, the VIS transmitter and receiver would be located approximately 7000 feet north of the IRI along the north/south trail road. For the transmitter, the center masts would be installed in the middle of an 8-foot by 8-foot gravel base pad. The four perimeter masts would each be installed on a 32-foot diameter gravel base pad.

Each of the elements for the receiver would be situated on an 8-foot by 8-foot gravel pad and connected to the other elements by narrow gravel pad walkways. A single trailer module would be required at the site, to house the associated electronic components for both the transmitter and receiver.



Side View (East-West) Magnetic



Side View (North - South) Magnetic

FIGURE 2.3-3. SIDE VIEW OF TRANSMITTER FOR PROPOSED VIS

Optical Imager. An optical imager photographs background ionospheric and auroral structures. The optical imager would be located in the same trailer module as the Infrared Imager. At the Gakona Site, the optical imager would be located 9500 feet north of the IRI along the north/south trail road. The optical imager would be located in the other half of the trailer module as the infrared imager.

Infrared Imager. The infrared imager would be used to define the latitudinal position, structures, and changes within the aurora. An infrared imager is an optical instrument housed in a trailer module with a clear dome on the roof.

At the Gakona site the infrared imager would be located 9500 feet north of the IRI along the north/south trail road in a trailer module with the optical imager. The trailer module would be situated on a 50-foot by 50-foot gravel pad.

Magnetometer. A magnetometer measures the variations in the earth's magnetic field associated with the aurora. A magnetometer is a magnetic loop antenna and associated electronic equipment housed in a 3-foot by 3-foot by 1.5-foot box. At the Gakona site, the magnetometer would be located 9500 feet north of the IRI along the north/south trail road, on the same gravel pad as the imaging instruments discussed above. The magnetometer would be surrounded by an 8-foot high wooden fence.

Light Detection and Ranging (LIDAR). A LIDAR is used to investigate the atmospheric chemistry associated with the aurora. It is an optical instrument which would be located in a trailer module, with a clear dome on the roof.

At the Gakona site, the LIDAR would be located 4000 feet north of IRI along the north/south trail road and approximately 1000 feet east of the ISR on a presently uncleared portion of the site. The LIDAR site would require a 50-foot x 50-foot gravel pad and a 12-foot wide gravel access road 1,000-foot long, east of the trail road.

Off-Site Diagnostics. The following off-site diagnostics have currently been identified for possible utilization with the IRI: imaging riometer; HF/VHF radar; VLF receiver; scintillation receiver; and, an ELF/VLF receiver. The actual composition of off-site diagnostics is likely to change depending upon experimental requirements and technical evaluation of the program. The use of these off-site diagnostics are not evaluated in detail in this EIS because their locations are generally dependent upon experiment requirements, and because the off-site diagnostics are not required for basic HAARP operation. Subsequent appropriate environmental analysis will be completed for the off-site diagnostics prior to any decision to add them to the facility.

A riometer monitors background radiation from the galaxy and enables a photographic-like image to be formed of the lower ionosphere. The riometer would consist of 256 antenna masts, 8 feet in height, and arranged in a 16 by 16 grid. The riometer would require an area about 270 by 270 feet. Most of this area would be covered by a 250 by 250 foot groundscreen.

A HF/VHF radar is used to detect the presence of smaller scale ionospheric structures within the lower ionosphere. The HF/VHF radar would consist of a transmitting radar and a receiver site. The HF/VHF radar transmitter would consist of a 260 by 525 foot antenna array. The receiver would require an area of about 165 by 165 feet.

A VLF receiver is used to determine changes in the lower ionosphere. The VLF receiver would likely be mounted on the roof of an existing building.

A scintillation receiver is used to monitor the characteristics of satellite radio wave transmissions that pass through the ionosphere. The scintillation receiver system would require an area of about 656 by 1312 feet.

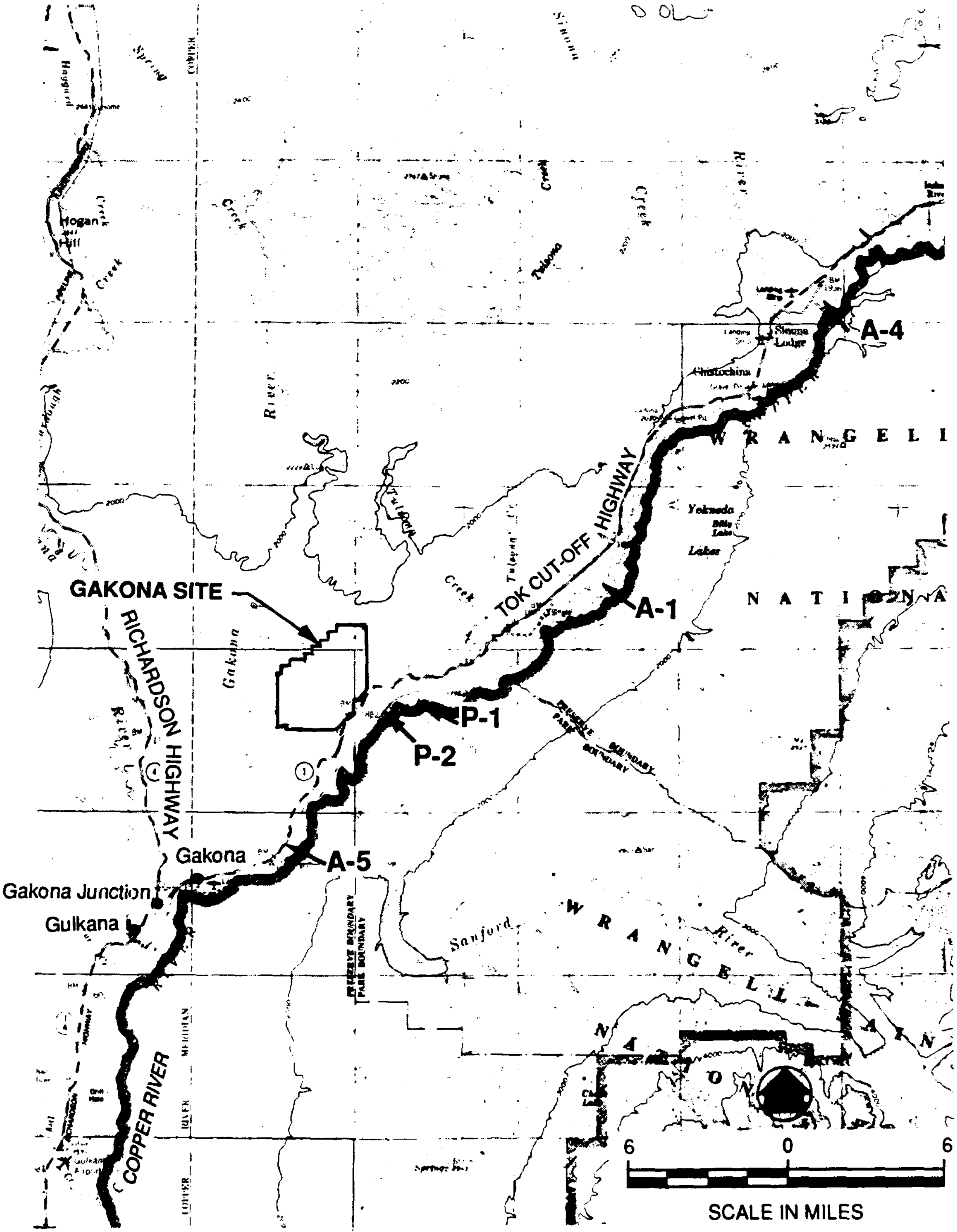
An ELF/VLF receiver is used to monitor the propagation of ELF/VLF radio waves. The ELF/VLF receiver would require one or more sites about 330 by 330 feet in size.

Gravel Sources. Although final designs are not available, preliminary estimates indicate that the construction of the HAARP IRI and on-site diagnostics would require approximately 160,000 cubic yards of non-frost susceptible gravel. This would require approximately 7,300 haul trips, assuming a haul unit capacity of 22 cubic yards. Depending on pit run quality, crushing and or screening equipment might be required to process the gravel.

It is anticipated that gravel would be obtained from a nearby source. Five potential gravel sources, all within 24 miles of the Gakona site, have been evaluated. The locations of the gravel sources, identified as P1, P2, A1, A4, and A5 are shown in Figure 2.3-4. These sources were previously selected as part of the OTH-B program at Gakona. The previously used number convention has been retained to aid the reader. The HAARP project would require less than one-tenth of the 2.5 million cubic yards of fill previously required for the OTH-B project.

All the OTH-B gravel sources would be available to the construction contractor. Other borrow sites not mentioned in this document could be identified and used by the construction contractor. The following discussion is based largely on the Borrow Removal Technical Study (M&E/H&N, 1989a) which was prepared for the OTH-B program.

Gravel Source P1. The center of this area is approximately 2.5 miles east-southeast of the HAARP site and is a former stream-bed of the Copper River that was formed when the river was at a higher elevation. The approximate 9,000-foot long, 1,400-foot wide area is bounded on the south and west by the Copper River channel and on the north by a steep bluff eroded by the Copper River. The eastern boundary is formed by the existing Alaska Department of Transportation (ADOT) pit 46-1-018-5 and the Copper River. It is approximately 5 feet above the present Copper River channel. Tulsona Creek enters the area from the north near the ADOT borrow pit, partially crosses the area twice, and then follows the old flow channel along the toe of the bluff to its confluence with the Copper River. The material in this area is stratified, river-deposited cobbly sand and gravel with discontinuous permafrost. Groundwater was present at some boring locations at depths ranging from 3



Source: USGS Topographic Map
Gulkana, Alaska (1959)

FIGURE 2.3-4. POTENTIAL GAKONA GRAVEL SOURCES

to 8 ft, with an average depth of 5 feet indicating stockpiling and draining would likely be required. Tests performed on materials at the adjacent ADOT pit indicate that the gravel is suitable for all fill requirements and for processing as sub-base, base, and surface courses for roads (M&E/H&N, 1989a). Based on an assumed excavation depth of 15 feet in usable soil and a 100-yard buffer next to the Copper River, this source could provide 2.5 million cubic yards of gravel, over 10 times the amount required for the construction of the HAARP research facility.

The haul distance from the antenna site along the Glenn Highway and existing haul road to the center of the borrow area is approximately 4 to 5 miles. A more direct route could be achieved by constructing a new haul road along an existing drainage swale, from the Glenn Highway across Tulsona Creek to the western end of the site. The new road would reduce the haul distance to the center of the area to about 2.3 miles, but would require constructing about 1.3 miles of new haul road (possibly over wetlands) and a crossing over Tulsona Creek.

Gravel Source P-2. This source is located approximately 1.5 miles southeast of the research site and 2,000 feet west of source P-1. The 5,000-foot long and 1,000-foot wide, gravel source is bounded on the south and east by the Copper River and on the north and west by steep slopes that separate it from the upland plain. The area consists of four terraces and a section of the Copper River floodplain. It is generally well-drained, and a drainage swale traverses the area from north to south. Subsurface investigations indicated that the usable sand and gravel strata are discontinuous and shallow in spots, and ice was common in both the overburden and the sand and gravel strata. Overburden layers are approximately 7-foot thick. Although P-2 is the shortest haul distance to the proposed site, about 2 miles of haul road would have to be constructed.

Based on an assumed pit depth of 9 feet and development of 30 acres within the pit, approximately 400,000 cubic yards of gravel could be obtained from this site. The presence of frozen strata in both the overburden and the sand/gravel layers would require stockpiling

and draining of any removed material. Containment dikes would be required to stockpile stripped overburden.

This borrow area has the advantages of being the shortest haul distance of any of the areas investigated and of having relatively good drainage. However, despite its close proximity to the site, the extent and makeup of the overburden material make this source less desirable (M&E/H&N, 1989a).

Gravel Source A-1. This area, about 11 to 12 miles northeast of the antenna site, consists of an upper, flat-topped terrace of the Copper River (in the eastern third of the source) and a lower terrace in the western portion of the source. The terraces are associated with the Copper River and are divided by a drainage channel that runs northeast-southeast from the Glenn Highway to the Copper River. The drainage channel is bordered by wetlands. An existing ADOT pit encroaches on the eastern portion of the upper terrace. Ponds are located on both the upper and lower terraces. A 500,000-square-foot pond abuts the northwest portion of the site. The area has a 3.5-foot to 5-foot layer of peat/silt overburden; the underlying sand and gravel strata contain permafrost at 2.5 feet - 4.0 feet and ice lenses in most areas, as well as a base layer of clay (at 16-foot to 29-foot depths) (M&E/H&N, 1989a).

Based on an assumed overall excavation depth of 15 feet and development of 76 acres within this area, the total usable volume is approximately 1.6 million cubic yards (M&E/H&N, 1989a). The presence of several shallow ponds indicates that soils may vary widely through the site, requiring more detailed subsurface testing before use. The estimated quantity of usable gravel in the upper terrace of gravel source A-1 is estimated to be 320,000 cubic yards based on an average thickness of 15 ft, excluding the pond area. This quantity of gravel is enough to be relied upon as a sole source. The estimated quantity of usable soil in the lower terrace excluding the drainage swales and assuming an average thickness of 18 feet is 1.5 million cubic yards, which is more than enough for the HAARP project.

The gravel from this source could be transported to the Tok Cutoff over an existing haul road or by constructing a new haul road, 1/4 mile in length, along the drainage swale and into the center of the borrow area. This new road would be required for efficient development of the tower terrace. Area A-1 can be easily accessed and has suitable material.

Gravel Source A-4. This area is located in a broad, glacial outwash plain approximately 24 miles northeast of the antenna site. It extends from the Glenn Highway on the north about 4,500 feet to the Copper River on the south. The eastern boundary consists of lowlands adjacent to the Copper River. ADOT and private pits are located on both the east and west sides of the area. Results from two borings indicate that an acceptable sand and gravel layer extends to depths of at least 14 to 22 feet beneath a 2-foot to 2.5-foot layer of organic silt/sand overburden. Some permafrost was encountered at 5 ft; no groundwater was encountered (M&E/H&N, 1989a).

The lack of subsurface information for this site precludes making a well-reasoned estimate of total fill availability. However, the results of two borings and the experience with existing ADOT pits in the area indicate that borrow area A-4 has the potential to yield much larger quantities than any other Gakona source evaluated.

An existing road, requiring only minimal repair, would provide access to the gravel source from the Tok Cutoff. The haul distance would be approximately 25 miles.

Gravel Source A-5. This source is located approximately 6.5 miles southwest of the antenna site. It is bounded on the west, south, and east by the Copper River, and on the north by the Glenn Highway. It consists of a generally flat to gently sloping former channel of the Copper River, and it lies mostly within the present inactive floodplain (except for the western portion, which is crossed by Copper River overflow channels). The site is an extension of an existing ADOT pit. Results of six borings indicate the presence of a deep stratum (at least 19 ft) of cobble, sand, and gravel overlain by a 0.5-foot to 1.0-foot peat

and silty sand layer of unusable overburden. Groundwater was generally observed at 1.5-foot to 6-foot depths; permafrost was not observed (M&E/H&N, 1989a).

Based on an assumed excavation depth of 9 feet and a 225-foot buffer along the Copper River, the area that could potentially be developed is about 113 acres and would yield about 1.5 million cubic yards of material. Groundwater level near the surface and the expected presence of oversize cobbles within the sand and gravel layer could increase the excavation effort and reduce the amount of usable material.

An existing haul road could be used for hauling gravel from the source to the Tok Cutoff. The eastern half of the area could be more efficiently developed by constructing a new haul road along an existing trail west of the erosion bluff that forms the northeastern boundary of the area.

2.3.2 Alternative Site - Clear

The proposed alternative site would include land both at Clear AFS (Figure 2.3-5) and at a location 10 miles south of Clear AFS, between the Nenana River and the Parks Highway, north of Bear Creek, approximately at milepost 269. The portion of the Clear AFS for use by HAARP will hereafter be referred to as the Clear AFS property. The siting area near Bear Creek will be referred to hereafter as the Bear Creek location. The Clear AFS property and the Bear Creek location will be collectively referred to as the Clear site. This non-contiguous site would be required to prevent mutual interference problems between the operation of the essential on-site diagnostic equipment, ISR, and the operation of the existing Ballistic Missile Early Warning System (BMEWS), which is currently the sole mission of Clear AFS. The Bear Creek location is the only location within the maximum separation distance from the proposed IRI site that provides electromagnetic screening from the BMEWS.

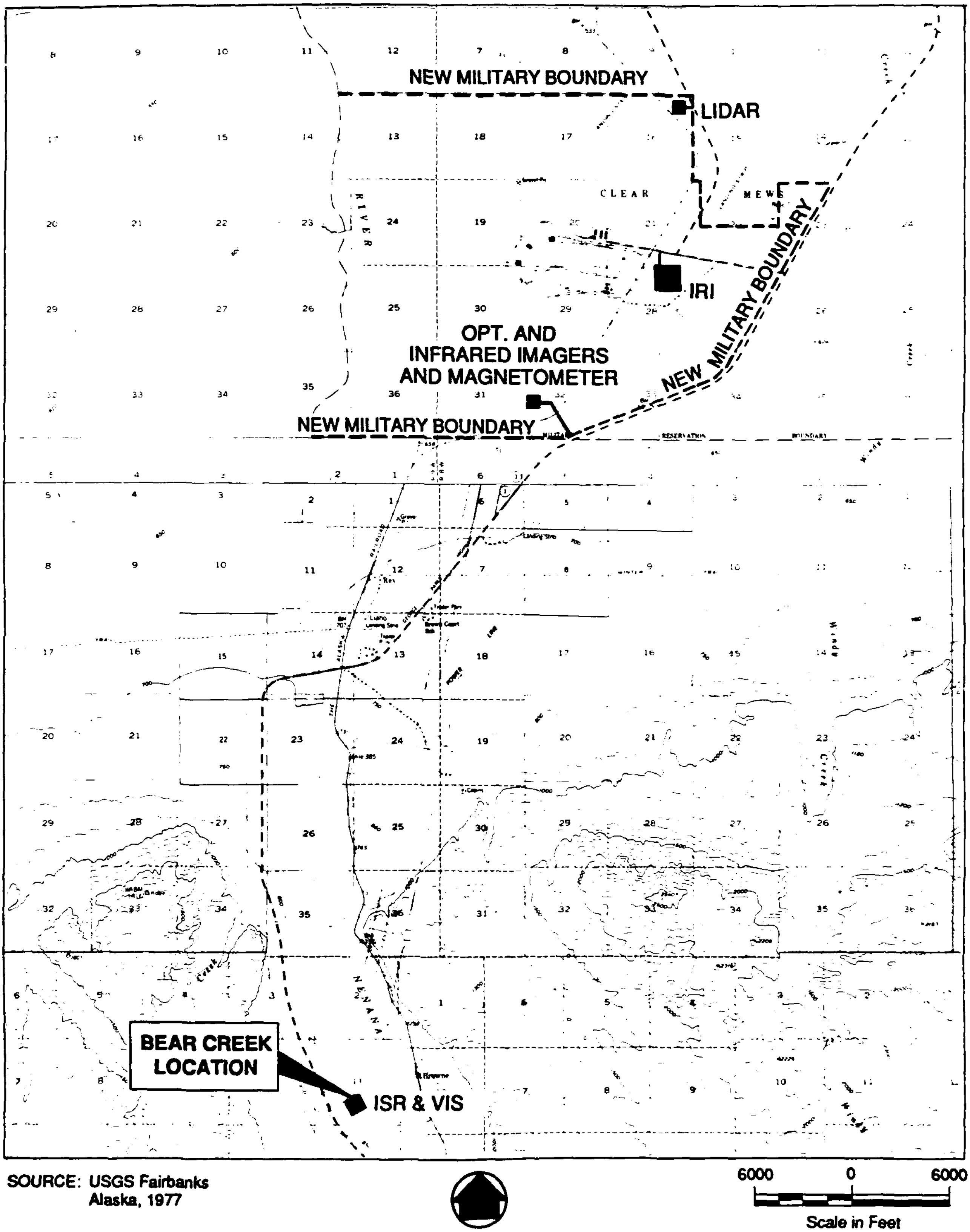


FIGURE 2.3-5. CLEAR SITE CONCEPTUAL LAYOUT: INCLUDING CLEAR AFS PROPERTY AND BEAR CREEK LOCATION

IRI and Support Facilities. The IRI at the Clear AFS property would be configured in the same manner as described in the Gakona site in Section 2.3.1. The IRI would be located on the Clear AFS property, east of the existing Alaska Railroad right-of-way and south of the roadway leading to Clear AFS and the town of Anderson (Figure 2.3-5). Approximately 1000 feet of access road would be constructed connecting the currently uncleared IRI site to the existing roadway.

Operations Center. The operations center would occupy an area 65 feet wide by 150 feet long. The operations center would be located in a new structure, at the end of the proposed access road, near the IRI on Clear AFS property. The operations center would include the following: a site entry control point, an office and shop for site maintenance, minimal supply and storage areas for site support, the IRI control room, a conference area, a break room, rest rooms, an instrument control room for the ISR and other on- and off-site diagnostics, mechanical and electrical utility rooms, three offices for research scientists, a fire protection system, a wastewater system, and a communication system.

Power Sources. The HAARP facility would utilize two primary power sources. All power requirements of the IRI and the other diagnostics located on Clear AFS property would be provided by the existing powerplant at Clear AFS, and/or a commercial power grid. The existing Clear AFS powerplant is a coal fired, steam turbine driven generator facility with the rated capacity of 22.5 MW (3 boilers at 7.5 MW each). Some modification or expansion of the existing powerplant may be necessary to meet the anticipated loading of HAARP.

The power for the Bear Creek location would be obtained commercially from the high voltage transmission lines which follow the Parks Highway. This would require construction of a relatively small power substation. The power would be used for all functions at the location. Backup diesel generators would provide emergency power for the heat and lighting should the commercial power fail. There would be no backup power source for the actual operation of the ISR and the VIS.

On-Site Diagnostic Equipment. On-site diagnostic equipment would be the same as discussed in Section 2.3.1 for the Gakona site. Of the diagnostic instruments, the ISR and the VIS would be placed at the Bear Creek location (Figure 2.3-6). Access to the Bear Creek location would be via an approximately 1000 foot access road connecting to the Parks Highway. Power lines would be buried along the access road to the instruments and connected to the high voltage tie-line that runs parallel to the Parks Highway. A large earthen mound (110 feet high) would be constructed north of the ISR to improve electromagnetic shielding from the BMEWS radar located on Clear AFS. This mound would be constructed using the near-surface material scraped from the instrument site areas. The land at the Bear Creek location is currently owned by the state of Alaska, with some personal homesteading activities in the area. Descriptions of the ISR and VIS were provided in Section 2.3.1 under the Gakona site.

The other diagnostic instruments, the infrared imager; optical imager; magnetometer; and, LIDAR will be located on the Clear AFS property (Figure 2.3-7). Access to these diagnostics will require the construction of two gravel access roads (a total of 3000 feet in length). Data, power and communication lines would be buried along both the access roads to the various instruments and along the edge of the Alaska Railroad right-of-way. Instrument configurations would essentially be the same as at the Gakona site (See Section 2.3.1 Gakona Site). Each of the diagnostic areas would be enclosed in a fence for security and safety reasons.

Off-Site Diagnostics. Off-site diagnostics were previously discussed for the Gakona site and are the same for this alternative. They are not required for basic HAARP operation. As was stated previously, subsequent tiered NEPA documents will be prepared for these diagnostics as better information on their nature and location becomes available.

Gravel Sources. Construction of the HAARP facilities at Clear AFS would require approximately 16,000 cubic yards of gravel at the Clear AFS property, and about 15,000 cubic yards at the Bear Creek location. This corresponds to about 700 haul trips at each of the two locations and assumes a 22 cubic yard haul capacity. Most of the gravel required for

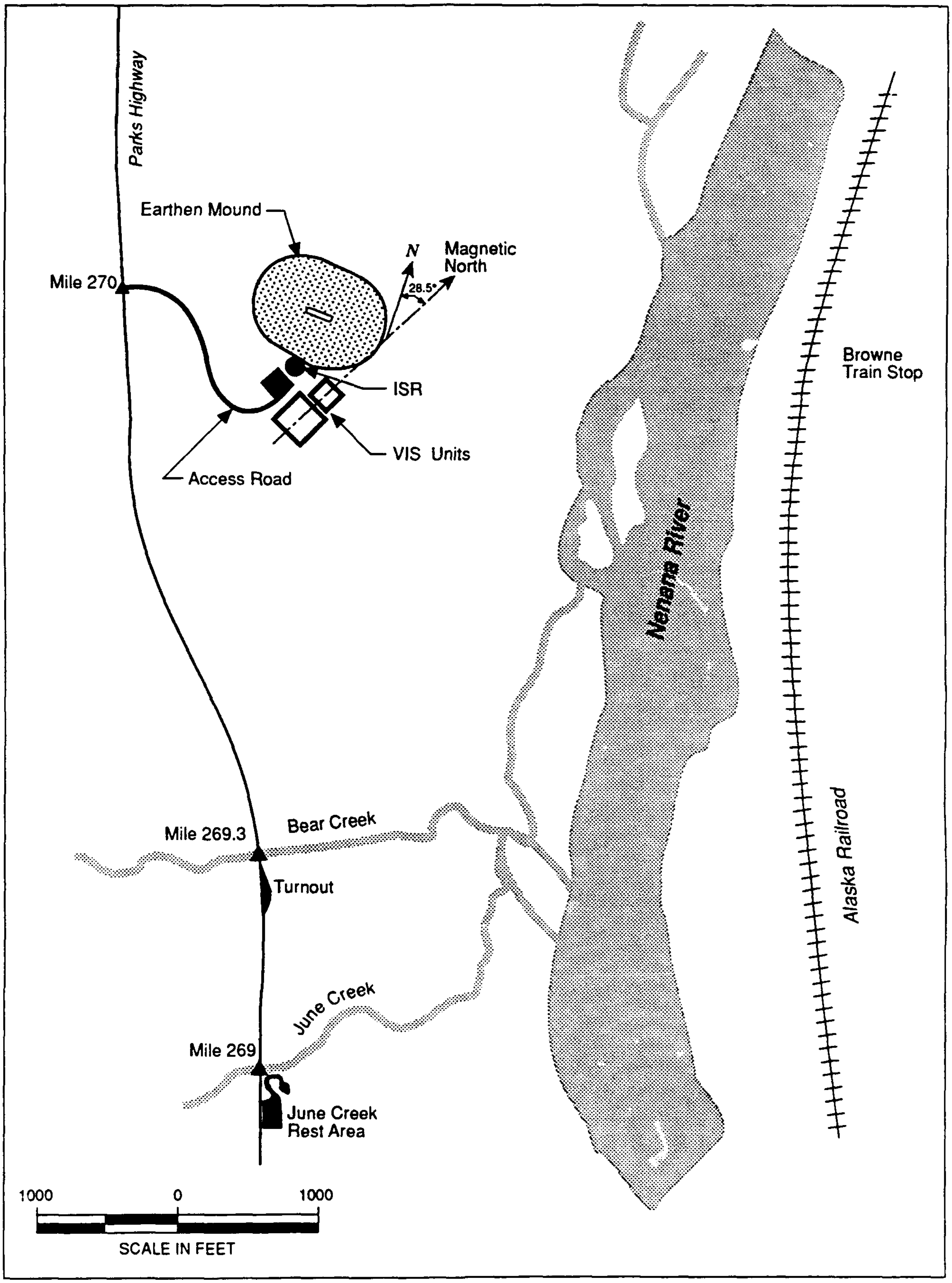


FIGURE 2.3-6. BEAR CREEK LOCATION

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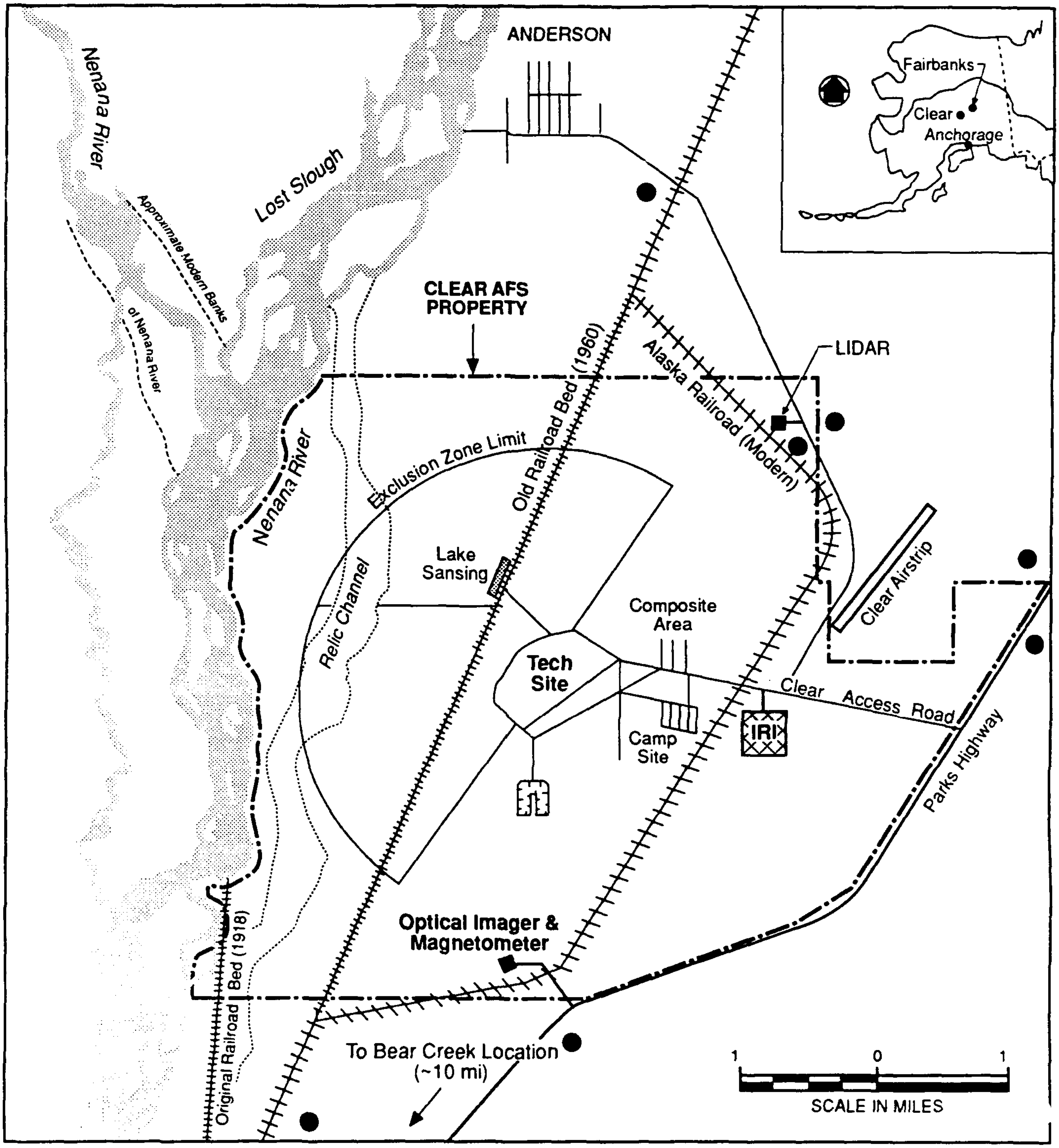
construction would be used for the access roads and parking areas and should be of similar quality.

Clear AFS property is underlain by a broad glaciofluvial outwash plane that is comprised mostly of sands and gravels deposited during the pleistocene series, over-lain by river sediments and loessial silt deposited during the recent age. The top layer of material ranges from 1 to 6 feet thick, and the gravel outwash below is in excess of 400 feet thick in many places (Shannon & Wilson, 1958). This condition sets the stage for an area rich in sand and gravel material. There are currently numerous gravel borrow areas at the Clear AFS where material has been mined for past construction projects (Figure 2.3-7).

Due to the abundance of gravel and sand material in the area, it is anticipated that gravel would be mined from a nearby source, probably less than 2 miles away. This is the case for all of the 16,000 cubic yards required at Clear AFS property.

The Bear Creek location is located in the foothills of the Alaska Range, approximately 10 miles south of Clear AFS. It is anticipated that this site would exhibit similar subsurface characteristics as the Clear AFS property with a silty loessian mantle underlain by sand and gravel. Although no sand and gravel borrow areas are known to exist in the immediate area, obtaining 15,000 cubic yards for the construction of the Bear Creek location is not foreseen to be a major obstacle. As a worst case scenario, gravel material would be hauled from the Clear AFS borrow areas discussed above. This would involve a round trip haul distance of about 24 miles.

The construction contractor would be able to choose from which site the borrow material would come for construction of the facilities. This decision would be based on both cost and construction requirements. Gravel obtained from the Clear AFS borrow areas would be provided at no cost to the contractor as part of government furnished equipment and supplies. If the contractor were to acquire gravel from off-site sources, they would be responsible for the



SOURCE: M&E, 1992

● Potential Gravel Sources

FIGURE 2.3-7. GRAVEL SOURCES IN THE CLEAR AFS AREA

cost of the gravel and any necessary permitting or impact studies associated with mining gravel at alternate sites.

2.3.3 No Action

The no action alternative is to not construct a HAARP facility. This alternative would preclude pioneering ionospheric research which cannot be accomplished at any existing facility, and therefore would inhibit potential applications of HAARP research for advancing communications and surveillance technology. Technology for improved local and world-wide communication, clearer television and satellite communications, and enhanced radiotelescope research of the universe would be delayed. Furthermore, and possibly more important, is the loss of the potential for a new era of unknown technology that could be developed from a better understanding of ionospheric processes.

The no action alternative would have none of the impacts associated with the construction and operation of a HAARP research facility and would mean that the Gakona and Clear sites would not be used for HAARP. If no alternate use is identified for the Gakona site, then the USAF must promptly proceed with the reclamation of the site in accordance with the *ARS Termination Plan* approved by the Corps of Engineers, Regulatory Branch as a modification to the OTH-B ARS, Clean Water Act Section 404 permit for wetland fill. The major points of the site reclamation outlined in the ARS Termination Plan (USAF, 1991) are the following:

- Remove the powerplant building and all associated structures and equipment
- Excavate and properly dispose of approximately 3-4 feet of the uppermost gravel from the powerplant pad (roughly 400 feet by 490 feet in area)
- Remove the thermosyphons which comprise the gravel pad refrigeration system
- Scarify the remaining gravel of the powerplant pad and access road

- Remove the seven drainage culverts along the access road

- Construct gravel bars along the road to permit cross-drainage and to prevent ponding and erosion

Currently, the only alternate use identified for the Gakona site is the proposed HAARP research facility. The no action alternative would therefore result in the near-term initiation of the reclamation for the Gakona site.

2.4 COMPARISON OF ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

The major environmental consequences of the alternatives are compared in Table 2.4-1. The comparisons are based on the information and analyses presented in sections 3.0 Affected Environment, and 4.0 Environmental Consequences. The alternatives under consideration include the two action alternatives that involve the construction and operation of the HAARP facility at either the Gakona site or the Clear site and the no-action alternative of not to build.

Some limited programatic comparisons between the potential impacts associated with off-site diagnostics for the Gakona site and the potential impacts associated with off-site diagnostics for the Clear site can be made. More detailed comparisons are not possible because little is known about their siting requirements. Equipment siting would vary depending upon scientific requirements and final IRI design. In general, the Gakona and Clear sites and the surrounding regions offer similar siting concerns. Both are about equal distances to a major river, a national park, and mountains. Both sites are located in flat, uniformly vegetated areas. Due to the consideration that must be given the BMEWS at Clear AFS, the Gakona site could offer slightly more land available for use for locating future on-site equipment. The Gakona region receives less use by tourists, suggesting that impacts to tourism might be less if the Gakona site were chosen. The Clear region, however, might provide slightly better wildlife habitat. The Clear region also probably has a greater density of archaeological sites. The Clear region generally has better soil conditions for construction and less privately owned land than the Gakona region. However, these general differences may not be realized when siting diagnostic equipment since local conditions would vary in both regions.

TABLE 2.4-1. COMPARISON OF ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

Resource	Gakona Site Alternative	Clear Site Alternative	No Action Alternative
Land and Minerals	No significant impact on land and minerals as a result of site development. Some impact relating to development of gravel borrow areas around the Copper River. Clearing of land for access to borrow pits. Increased erosion in borrow pit areas. Possible stream or creek diversion. Degradation of permafrost could lead to subsidence, and increased erosion.	No significant impact to land and minerals. Removal of small quantities of borrow material from existing pits. Construction of an earthen berm at the Bear Creek location to shield the ISR unit from BMEWS. Land acquisition and possible disruption of homesteaders at the Bear Creek location. Impacts associated with near-term reclamation of Gakona site (see no action alternative).	No significant impacts. Near-term reclamation of the Gakona site (incl. demolition of existing PP building, removal of drainage culverts, removal of 3-4 feet of gravel on building pad, scarifying road surface). Land to be transferred or sold by GSA.
Vegetation and Wetlands	No significant impact on vegetation and wetlands. Total of about 51 acres impacted, 37 acres as a result of the IRI, 14 acres as a result of the diagnostics and roads. Loss of 18 acres of wetlands, mostly palustrine forested.	Significant impact to wetlands at the Bear Creek location. Total of 78 acres impacted, 37 acres as a result of the IRI, 41 acres as a result of the diagnostics and roads. *Loss of 36 acres of wetlands, mostly* scrub/shrub.	No significant impacts. No impacts to vegetation and wetlands at the Clear site. Net positive impact at Gakona site due to near-term reclamation effort.
Mammals	No significant impact to mammals. Minimal loss of habitat (none important or limiting). Some avoidance behavior modifications. Minimal increased human caused mortality.	No significant impact to mammals. Minimal loss of habitat. Some avoidance behavior modifications. Minimal increased human caused mortality. Some positive impacts associated with reclamation at Gakona site (see no action alternative).	No significant impacts. Increased browse at reclaimed Gakona site. Some short-term avoidance behavior during reclamation activities. No impacts to mammals at Clear site.

continued.

TABLE 2.4-1 continued. COMPARISON OF ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

Resource	Gakona Site Alternative	Clear Site Alternative	No Action Alternative
Birds	No significant impact to birds. 51 acres of habitat would be lost. Very little high-quality avian habitat would be destroyed. Some disturbance to individual trumpeter swans. Some possible impacts to nesting eagles possible during gravel extraction. Low potential of bird collisions with HAARP facilities for geese, raptors, and shorebirds. Higher potential of collision for ducks, swans, and passerines.	No significant impacts. About 78 acres of habitat would be lost. Some high-quality avian habitat would be destroyed. Low potential of bird collisions with HAARP facilities for geese, raptors, and shorebirds. Higher potential of collision for ducks, swans, and passerines. Some slight positive impacts associated with the reclamation at the Gakona site (see no action alternative).	No significant impacts. No impacts as a result of no action at the Clear site. Slight positive impacts associated with the near-term reclamation at the Gakona site.
Aquatics	No significant aquatic resources. Some potential for adverse impacts associated with gravel mining operations. Potential for fuel spill accidents associated with construction and operation would be minimal.	No important aquatic resources at the site. See no action alternative for impacts associated with Gakona site reclamation.	No impact at the Clear site. No impact at the Gakona site.
Hydrology and Water Quality	No significant impact to hydrology or water quality. Alteration of drainage patterns. Gravel removal could increase erosion and cause stream siltation.	No significant impact to hydrology or water quality. Alteration of drainage patterns. See no action alternative for impacts associated with Gakona site reclamation.	No significant impacts. No impact at the Clear site. Impacts at the Gakona site include changing the surface drainage patterns.
Air Quality	Potentially significant impact to air quality. Impacts on air quality during construction include emissions from internal combustion engines, and the generation of fugitive dust. Operational impacts from operation of diesel engine powerplant.	No significant impact to air quality. Impacts on air quality during construction include emissions from internal combustion engines and the generation of fugitive dust. Minimal impacts associated with increased emissions from Clear AFS powerplant or commercial power supply. See no action alternative for impacts associated with Gakona site reclamation.	No significant impacts. No impact at Clear site. Impacts on air quality during reclamation at the Gakona site include emissions from internal combustion engines, and the generation of fugitive dust.

continued.

TABLE 2.4-1 continued. COMPARISON OF ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

Resource	Gakona Site Alternative	Clear Site Alternative	No Action Alternative
Socioeconomics	No significant positive or negative impact to socioeconomics. Positive impact on the economy during construction and operation. Some potential impacts on aircraft operations.	No significant positive or negative impact to socioeconomics. Positive impact on the economy during construction and operation. Some potential impacts on aircraft operations. See no action alternative for impacts associated with Gakona site reclamation.	No significant impacts. No impact at Clear site. Short-term positive economic impact associated with the reclamation at Gakona.
Cultural Resources	No significant impact to cultural resources. Minimal chance of impact at Gakona site. Higher possibility of an impact at borrow areas. No impact to eligible NRHP sites.	High probability of negative impact associated with disturbing archeological sites. No impact to known eligible NRHP sites.	No significant impact. No impact at Clear site. No impact at Gakona site associated with the reclamation effort.
Subsistence	No significant impact to subsistence. Limited loss of habitat. No significant long-term impacts to population abundance. Minimal amount of short-term and temporary impact on distribution patterns of subsistence game. Loss of access to subsistence resources is minimal to non-existent. Section 810 determination yields no large or substantial effects on subsistence at the Gakona site.	No significant impact to subsistence. No significant long-term impacts to habitat or population abundance. Minimal amount of short-term and temporary impact on distribution patterns of subsistence game. Loss of access to subsistence resources would be minimal to non-existent. See no action alternative for impacts associated with Gakona site reclamation. Section 810 determination yields no large or substantial effects on subsistence at the Clear site.	No significant impact. No impact at the Clear site. Possible small positive impact associated with the near-term reclamation at the Gakona site. Section 810 determination yields no large or substantial effects on subsistence as a result of the no action alternative at either of the sites.
Recreation	No significant impact to recreation. Access to lands north of the site would be maintained. Construction workers could increase hunting and fishing pressure on local fish and game, and compete with tourists for campsites. Use of Gakona site not expected to greatly change.	Significant impact to recreation, primarily limited to aesthetic values. Construction workers could increase hunting and fishing pressure on local fish and game, and compete with tourists for campsites. Aesthetic impacts of HAARP facilities could detract from wilderness recreational experience. See no action alternative for impacts associated with Gakona site reclamation.	No significant impact. No impact at the Clear site. Positive visual impact at Gakona site as a result of the powerplant building and the access road being reclaimed.

continued.

TABLE 2.4-1 continued. COMPARISON OF ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

Resource	Gakona Site Alternative	Clear Site Alternative	No Action Alternative
Aesthetics	No significant impact on aesthetics. Minimal visual impacts from roadway and residences. Moderate impacts as viewed from small aircraft.	Significant impacts. Insignificant visual impacts at Clear AFS property. Significant visual impacts at Bear Creek location as viewed from highway, railroad tracks, and river, as well as from private dwellings.	No significant impact. No impact at the Clear site. Slight positive impact associated with the reclamation at the Gakona site.
Bioeffects of Radio Frequency Radiation	No bioeffects from RFR. No impacts to humans or other mammals outside of IRI exclusion fence. No impacts to birds.		No impact at the Clear site. No impact at the Gakona site.
Electromagnetic and Radio Frequency Interference	Potential significant interference to radio communication systems and electroexplosive devices during transmitting periods. Extent of the interference is difficult to reliably predict, would be mitigatable.		No impact at the Clear site. No impact at the Gakona site.
Atm osphere	No significant impacts to the atmosphere. The proposed IRI would transmit radio waves of sufficient intensity to cause measurable changes in the composition of the ionosphere. These changes would be insignificant in both magnitude and duration compared to natural processes. No effect on the ozone layer or the visible aurora.		No impact at the Clear site. No impact at the Gakona site.
Threatened and Endangered Species	No impact.	No adverse (or significant) impact to threatened or endangered species. One threatened and one endangered species may occur at the site. Impacts to either would be unlikely. Formal consultation with US Fish and Wildlife Service under Section 7 of the Endangered Species Act not necessary.	No impact at the Clear site. No impact at the Gakona site.
Hazardous Materials and Wastes	No significant impact. Storage of 200,000 gallons of fuel oil. Storage areas and handling procedures not presently identified but be developed through a SPCC.	No significant impact. Minimal amounts of fuel storage. Storage and handling would be integrated with existing practices at Clear AFS.	No significant impact. Minimal amounts of materials during Gakona site reclamation.

continued.

TABLE 2.4-1 continued. COMPARISON OF ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

Resource	Gakona Site Alternative	Clear Site Alternative	No Action Alternative
Irretrievable Commitment of Resources	Footprint requires about 51 acres of land, 18 acres of which would be wetlands. Moderate amounts of gravel. Fuel for power would be diesel oil.	Footprint requires about 78 acres of land, 36 of which is wetlands. Minimal amounts of gravel required. Fuel for power would likely be coal.	Small amounts of fuel for the Gakona site reclamation.

2.5 IDENTIFICATION OF THE PREFERRED ALTERNATIVE

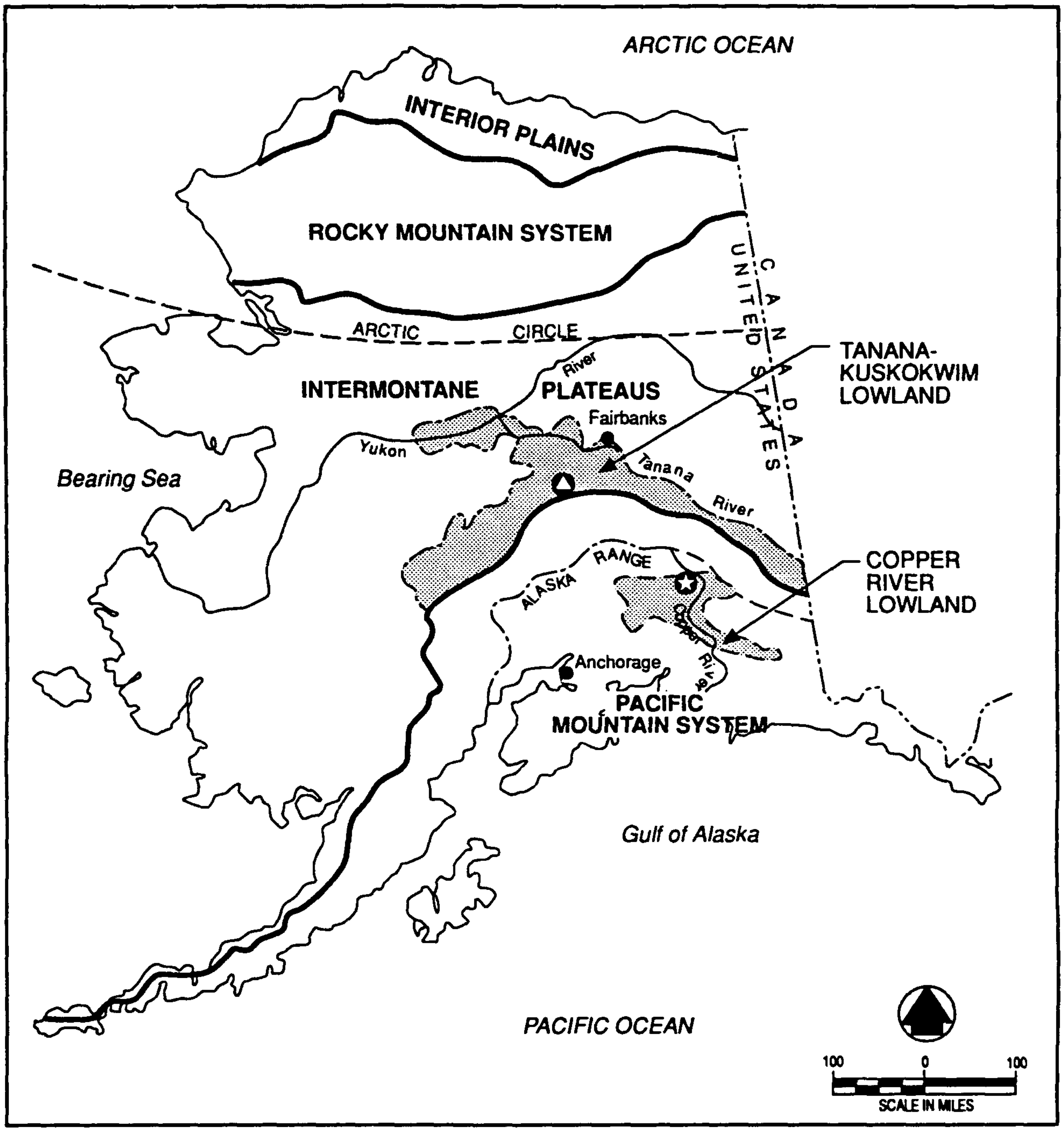
The preferred alternative is to construct the HAARP facility at the Gakona site.

3.0 AFFECTED ENVIRONMENT

This section describes the existing environment in the two areas of Alaska identified for potential construction of the HAARP facility. Environmental resources are typically described at three levels of detail including region, site, and conceptual layout. The **Gakona Site** and **Clear Site** have been defined and are referred to earlier in Section 2 of this document. **Gakona Region** refers to the Copper River Lowland as delineated on Figure 3.0-1 unless otherwise stated. **Clear Region** refers to the Tanana-Kuskokwim Lowland as delineated on Figure 3.0-1 unless otherwise stated. The **conceptual layout** is the proposed location of the HAARP facility and associated structures on the Gakona and Clear sites.

Primary sources of information, especially for the Gakona site, were studies conducted as part of the Air Force's Over-the-Horizon Backscatter (OTH-B) and include USAF (1986a), USAF (1987), USAF (1989a), and M&E/H&N (1989b). The information in these references was updated or supplemented, where necessary, for use in this document.

Information for the Clear site was collected via interaction with various federal and state of Alaska government agencies, as well as with the Air Force and the Army Corps of Engineers and their agents. The Clear AFS Site Comprehensive Plan provided particularly valuable information in assembling this DEIS.



SOURCE: Waharhaftig, 1965

FIGURE 3.0-1. PHYSIOGRAPHIC PROVINCES OF ALASKA

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3.1 LAND AND MINERALS

3.1.1 Gakona Site

Physiography and Topography. The Gakona Site lies within the Copper River Lowlands (also known as the Copper River Basin) subdivision of the Pacific Mountain System (Figure 3.0-1). The Copper River Lowlands consist of an inter-mountain basin flanked on all sides by mountainous uplands. The eastern portion of this basin, which contains the Gakona site, is a plain with elevations ranging from 1,000 to 3,000 feet above mean sea level (MSL). This plain is dominated by glacial moraines and bedrock ridges that rise above the relatively flat glacial outwash surface (Emery et al., 1985). The lowland plain is bisected by the valleys of the Copper River and its tributaries, which have steep walls of up to 500 feet (USACOE, 1987a). Most of the rivers that traverse the lowlands are fed by glaciers. Large lakes occupy deep basins in the mountain fronts and thaw lakes are abundant on the eastern plain (Wahrhaftig, 1965).

The Gakona region is a gently southwest-sloping plain with numerous small lakes. Prominent features within this area include the Gulkana, Gakona, Sanford, and Copper Rivers and Tulsona Creek. On the Gakona site, elevations range from 1,940 feet in the northwest portion of the site to 1,830 feet in the southeast portion near the Glenn Highway. The site has relatively low topographic relief. It slopes downward to the southeast at a rate of 20 feet per mile in the lower portion and is nearly flat in the upper portion. Maximum slopes are about 4 percent (M&E/H&N, 1989c). The site is well-drained of surface water relative to the surrounding area. Although it does not contain lakes or defined stream channels, a number of poorly defined drainage channels cross the site. In addition, a few isolated ponds exist on the northern portion of the site.

Land Status and Existing Structures. The Gakona site is owned by the Air Force. Existing structures on-site include an incompletely constructed, 21,000 square foot, 73 foot tall

powerplant building and a gravel access road approximately 5,300 feet in length. The approximately 300-foot-tall Alascom microwave tower is located just outside of the eastern site boundary.

Geology and Permafrost Conditions. Soils in this general area are typically poorly drained, clayey loams with a peat surface layer and a shallow permafrost table (Selkregg, 1974). The fine-grained soils are susceptible to frost and moderately thick or thin permafrost may exist throughout the area. Alluvial sand and gravel in the area is generally limited to the river areas to the south and west of the site proper.

Several studies have been undertaken to define the specific subsurface conditions of the Gakona site. Site-specific explorations to date include 7 boreholes drilled by the Army Corps of Engineers in 1987 (5 holes) and 1988 (2 holes) (USACOE, 1987a; 1988), and a series of additional borings conducted in 1989 (Moolin and Associates, 1989). These test borings indicate that the site is overlain by a relatively thin mantle of peat and organic soils approximately 1 to 2 feet thick. The moisture content of these organic soils was found to generally vary from 50 to 100 percent (USACOE, 1987a). These surficial organics are underlain by lacustrine deposits predominantly composed of clays, clayey silts, and clayey sands. The clayey soils below the surficial organics occurred at depths generally ranging from about 15 to 20 feet and contain random gravel, cobble, and boulder-sized particles. Natural moisture contents (including ice formations) in this layer varied from 15 to 40 percent. The surficial clays were underlain by sandier and less plastic soils. Random gravel, cobble, and boulder-sized particles were encountered throughout this lower layer. Natural moisture contents (including ice formations) varied from 15 to 35 percent.

Permafrost temperatures on the Gulkana site are relatively warm, ranging from about 31°F to 32°F, making the area very sensitive to thermal disturbance at the surface (USACOE, 1988). The permafrost table occurred between 2 and 5 feet below the surface and may extend to a depth of 100 to 250 feet (USACOE, 1987a; Emery et al., 1985). Ice lenses up to 4 inches in thickness were observed throughout the deposit.

The Gakona site is on the margin between seismic probability zone 3 (major damage) and 4 (great damage) according to Army TM-5-809-10 (1982), "Seismic Design for Buildings". The corresponding seismic coefficients (Z) for these probability zones are 0.75 to 1.00, respectively.

Borrow Material. The Gakona and Gulkana Rivers, west of the Gakona site, meander within fairly well-defined drainage channels which may contain deposits of sand and gravel. The Copper River is braided with numerous channels, sand bars, and inflowing streams, creeks, and rivers. The Copper River Basin Area Plan (ADNR, 1986) has identified at least three material sites as critical for ADOT highway maintenance and construction along the Glenn Highway. The plan also identifies at least 10 privately owned material sites along both the Richardson and Glenn Highways in the Gulkana-Gakona region. These material sites have been characterized as thin terrace deposits and contain limited borrow materials. Seven potential borrow locations along the Copper River were also identified as part of OTH-B studies (M&E/H&N, 1989a). Three of these locations (P-1, A-1, and A-5) contain active Alaska Department of Transportation (ADOT) pits, two (P-2 and A-4) are currently unexploited. These five pits are currently the only sources being considered for use by the HAARP project. The remaining two OTH-B pits (A-2 and A-3) were removed from consideration due to the potential for disturbance of intact cultural resources (M&E/H&N, 1989a). The abundance of gravel resources on the Gakona site is expected to be low.

3.1.2 Clear Site

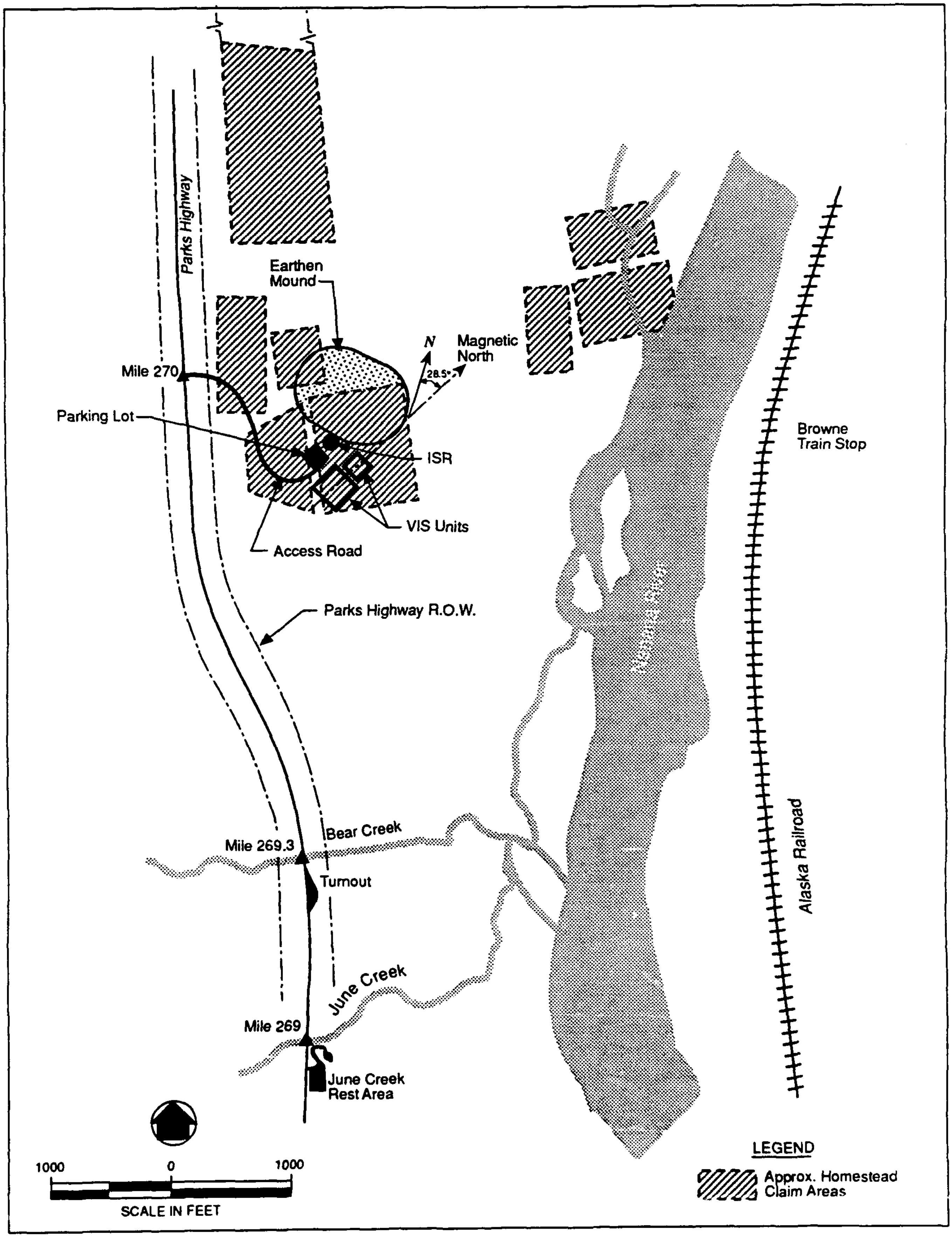
Physiography and Topography. The Clear Site lies near the Nenana River in the interior of Alaska about 10 miles north of the Alaska Mountain Range (See Figure 3.0-1). This physiographic region is known as the Tanana-Kuskokwim Lowland (Wahrhaftig, 1965). The Nenana basin slopes generally to the north away from the Alaska Range, where the Nenana River flows into the Tanana River, which is a major tributary to the Yukon River. The Yukon River drains much of interior Alaska. Although the Nenana River flows swiftly out of the Alaska Range, it slows through the foothills in the region near the Clear AFS and is characterized as a braided, slow flowing river.

The Clear AFS property is about 600 feet above mean sea level and the terrain is generally low in topographic relief in the immediate area, although within 10 miles the foothills of the Alaska Range rises to over 4000 feet. The general slope of the Clear AFS property is downward toward the north at a rate of about 2.5 feet per mile.

The Clear site (including the Bear Creek location) is located on a broad glaciofluvial outwash plain that is comprised of sandy gravel (UAF, 1987). This material is irregularly stratified with both well and poorly graded coarse sand (Shannon and Wilson, 1958). Because of the draining ability of this material, there are relatively few naturally occurring lakes or ponds in the region.

Land Status and Existing Structures. The majority of the proposed Clear site would be located on the existing Clear Air Force Station and is owned by the U.S. Air Force. The Bear Creek location is currently owned by the state of Alaska. The area has been designated to have a primary use of settlement (ADNR, 1991a). Several homesteads have been filed and the "proving up" process is on-going in the general area of the proposed diagnostics, although no deeding to private individuals has taken place at the time of this writing (ADNR, 1992b). Figure 3.1-1 shows the extent of homesteading claims at the Bear Creek location.

Clear AFS is a Ballistic Missile Early Warning System (BMEWS) site that is comprised of 11,438 acres of land located 78 miles south of Fairbanks on the Parks Highway (Mile 283.5). A short spur road to the west provides access to Clear AFS and the town of Anderson located several miles to the north. The Parks Highway forms the eastern boundary of Clear AFS and the Nenana River borders the installation to the west. The station consists of 144 buildings and structures, as well as 8.5 miles of paved and gravel roads, 2.9 miles of railroad trackage, and associated utilities to support the BMEWS program (FSI, 1991). The station employs approximately 370 persons, 120 of which are military personnel and the remainder are civilians. The facility is self-sufficient, providing all necessary living facilities for the personnel, including berthing, dining, recreation, and administrative space. Clear AFS has its own powerplant, water and wastewater systems, and solid waste disposal areas.



SOURCE: ADNR, 1992

FIGURE 3.1-1. HOMESTEADING CLAIMS AT THE BEAR CREEK LOCATION

Geology and Permafrost Conditions. The Clear site is located on a broad glaciofluvial outwash plain consisting of Pleistocene sediments and Tertiary gravels from the Nenana River. This outwash is composed of coarse, well-drained material such as sandy gravel, overlain by a thin organic mantle (3 to 12 inches thick) and about 4 feet of sandy silt (USACOE, 1982). The thickness of the sandy glaciofluvial deposit is reported to be several hundred feet. Below the gravel outwash is bedrock of the Birch Creek Schist variety, formed during the Precambrian era.

The Clear site is in a region of discontinuous or sporadic permafrost. The coarse-grained soils at this site are well drained and, thus, frost and permafrost related problems are not seen to be significant in this area. Subsurface investigations (Shannon and Wilson, 1958) indicate that irregular patches of permafrost have been encountered at Clear AFS at depths between 10 and 20 feet. This permafrost is described as "dry frozen" with water contents between 1.5 and 2.2 percent. The water table is between 75 and 90 feet below the surface (Shannon and Wilson, 1958).

Clear AFS is in seismic probability zone 4 according to Army TM-5-809-10 (1982), "Seismic Design for Buildings". It has been assigned a seismic coefficient (Z) of 1.00. This is a great damage zone and buildings and facilities should be designed accordingly. The area has experienced several major seismic shocks in the past, particularly the 1947 earthquake which measured 8+ on the modified Merchalli scale.

Because there has been little construction near the Bear Creek location, very little is known about specific subsurface conditions in this region. In a general sense the subsurface conditions are similar to that in Clear AFS as described above (USSCS, 1973). These soils are classified as being well-drained and formed in a shallow mantle of micaceous loess (wind-blown mica) over very gravelly and sandy alluvial deposits. Micro-geographic variations in this regime include areas of moderately well drained soils formed in a thick mantle of loess. This is common in areas such as Bear Creek where an outwash plane exists (USSCS, 1973).

Borrow Material. Subsurface information for the area surrounding the Clear site suggest an abundance of gravel and sand in this area due to the glaciofluvial nature of the deposit in this near-mountain area. Gravel for Clear AFS construction activities has been extracted from numerous locations over the years (FSI, 1991). Many of these borrow areas are located on Air Force property (M&E/H&N, 1992a). Gravel for the construction of the HAARP facility should be plentiful and easily obtainable at this site. Borrow material for the construction of the Bear Creek location facilities would be obtained either from sources on Clear AFS (approximately 24 miles away), or from a closer private or state-owned borrow pit.

3.2 VEGETATION AND WETLANDS

3.2.1 Gakona Site

This section discusses general habitat characteristics, vegetative associations and wetlands and documents the relative amounts of each identified cover type present at the Gakona site. The description of the existing vegetation and wetlands is based on vegetation maps previously prepared by AEIDC (1987a; 1988a) for a 59 mi^2 area, which included the Gakona site and several potential borrow locations along the Copper River and analyses of vegetation and wetland data conducted by M&E/H&N (1989b) from the same area. The methodology used during these previous studies is summarized below.

Vegetation and wetlands present on the 59 mi^2 area surrounding the Gakona site, as well as on potential borrow locations along the Copper River, were mapped from aerial photographs. The vegetation maps were then field verified by a qualified botanist (AEIDC, 1987a). Vegetation was classified on the maps according to the currently accepted Alaska classification system described in Viereck et al. (1986). Wetland determinations were completed according to the guidelines set forth in Cowardin et al. (1979) and USACOE (1984). The wetlands have not been reclassified according to the currently used guidelines in the *Corps of Engineers Delineation Manual* (USACOE, 1987b) guidelines, however there would be little if any difference in total amount and types of wetlands. The areal extent of each cover type present was determined from the maps for the entire 59 mi^2 area and for the potential borrow locations (M&E/H&N, 1989b).

Vegetation. The Gakona site is dominated by open conifer forest (53%), wet herbaceous (23%), woodland conifer forest (8%) and open low shrub (6%). An open conifer forest is primarily composed of conifers (evergreens with needles) that have a canopy coverage of 25 to 60%. A wet herbaceous vegetation association occurs in wet areas with grasses and sedges and is analogous to Cowardin et al.'s (1979) classification of palustrine emergent and the USACOE's (1984) emergent. A woodland conifer forest is primarily composed of conifers that have a

canopy coverage of 10 to 25%. An open low shrub vegetation association includes areas with low shrubs, devoid of trees, and a canopy coverage of 25 to 60% dry areas.

Potential borrow areas along the Copper River are generally dominated by open conifer and closed deciduous (trees that lose their foliage at the end of a growing season) forests (Table 3.2-1). The primary composition of the soils is well-drained gravel that usually, but not always, lacks permafrost. Van Cleve and Viereck (1981) discuss succession on glacial river outwash. The dominant vegetation at mature sites is white spruce. Earlier seral stages are dominated by willow, alder, and poplar. Much of the floodplain exists perpetually in early successional stages due to frequent disturbance by river flooding and scouring (Van Cleve and Viereck, 1981).

Wetlands. Wetlands are defined as areas having one or more of the following attributes: (1) periodic or permanent inundation or saturation with water (hydrology), (2) presence of plant species adapted for life in water or saturated soils (hydrophytic vegetation), and (3) presence of soils that are saturated or flooded for a long enough period during the growing season so that the upper layer becomes devoid of oxygen (hydric soils) (Cowardin et al., 1979). A substantial proportion of the Gakona site (70 percent) meets this definition and is classified as wetland (Figure 3.2-1). Classification of wetland cover types will follow Cowardin et al. (1979) in this document.

The majority of the wetlands on the Gakona site are palustrine forested wetlands dominated by conifers followed by palustrine emergent wetlands dominated by sedges and rushes. Minimal amounts of palustrine aquatic bed are present. Forested wetlands (equivalent to palustrine forested wetlands [Cowardin et al., 1979]) occupy 47 percent of the Gakona site. Forested wetlands are characterized by woody vegetation that is more than 20 feet in height. Common dominant species in this region of Alaska are white and black spruce, alder, willow, poplar, and

TABLE 3.2-1. PERCENTAGES OF COVER TYPES AT POTENTIAL BORROW LOCATIONS FOR THE GAKONA SITE AS COMPARED TO TOTAL BORROW AREA[1]

COVER TYPE	P-1		P-2		A-1		A-4		A-5	
	AREA	BUFFER[2]	AREA	BUFFER[2]	AREA	BUFFER[2]	AREA	BUFFER[2]	AREA	BUFFER[2]
Closed Conifer	3	23	<1	4	0	0	0	0	0	0
Open Conifer	0	31	0	8	40	24	43	45	9	3
Woodland Conifer	0	0	0	7	0	0	0	0	0	5
Closed Deciduous	71	21	<1	17	3	15	35	17	0	55
Open Deciduous	4	0	0	0	0	0	0	0	0	0
Closed Mixed	0	3	33	50	2	4	5	6	56	0
Open Mixed	0	2	0	0	0	0	0	0	0	0
Woodland Mixed	0	0	62	13	0	0	0	0	0	0
Closed Tall Shrub	0	0	0	0	0	0	17	20	2	9
Open Tall Shrub	1	3	1	2	2	19	0	3	<1	0
Closed Low Shrub	0	4	0	0	0	0	0	0	0	0
Open Low Shrub	0	0	0	<1	29	10	0	0	31	4
Wet Herbaceous	0	0	0	0	8	0	0	4	1	0
Fresh Water	0	8	0	0	6	0	0	1	<1	3
Barren-Natural	21	6	4	1	10	0	<1	2	1	22

[1] See Figure 2.3-4 for locations of potential borrow sites.

[2] Buffer represents an undisturbed band around the area to provide visual, ecological, and hydrological screening.

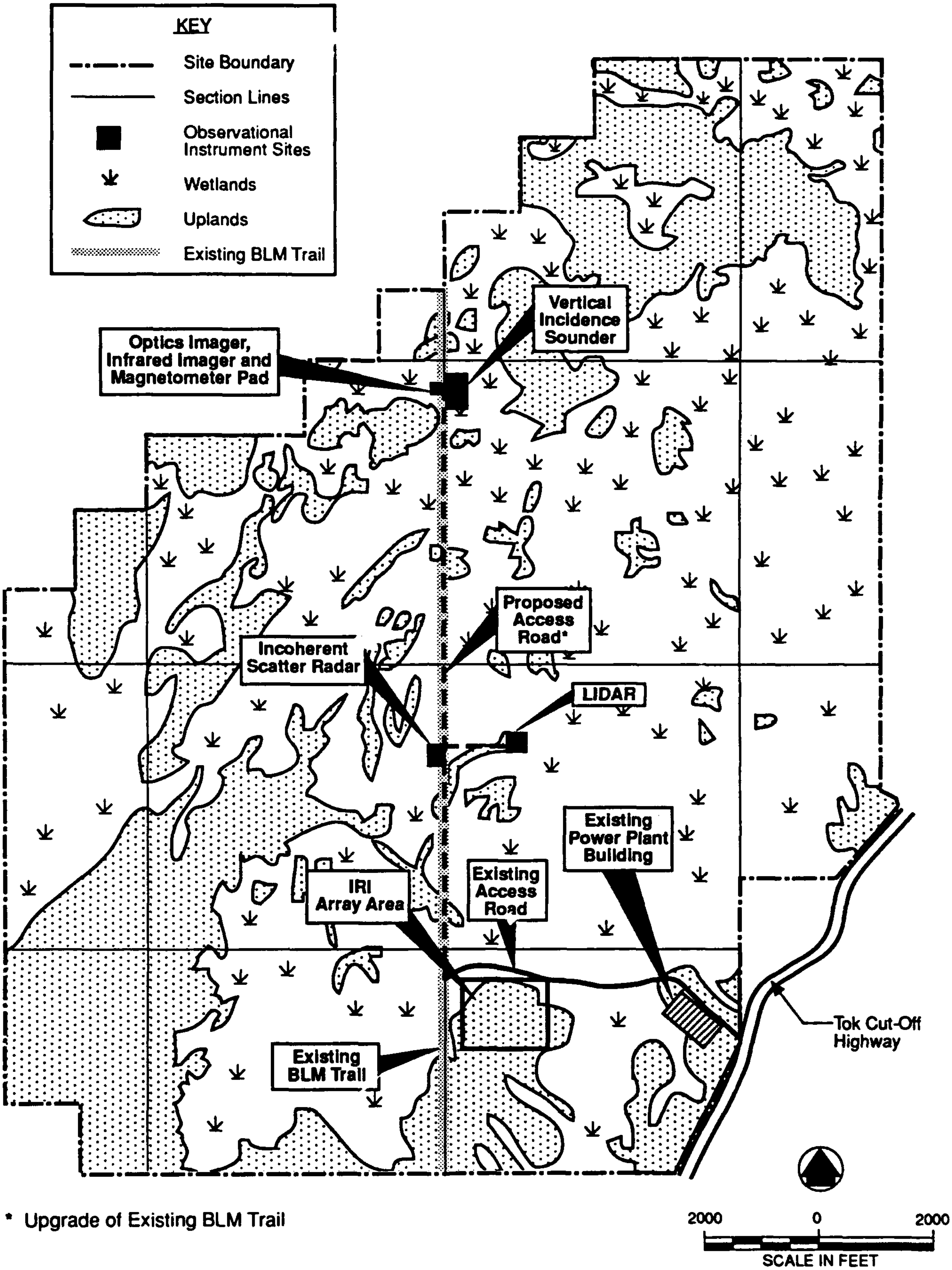


FIGURE 3.2-1. PROPOSED FACILITY LAYOUT AND WETLAND AND UPLAND HABITATS AT GAKONA SITE

2817CC-1 64/GE

tamarack. Sedges, bog blueberry, and *Sphagnum* moss are frequently present in the understory or ground layers.

There are no vegetated wetland habitats present on the borrow removal areas P-1, P-2, and A-4 and about 4 to 22 percent of the other alternate borrow removal areas are wetlands (Table 3.2-2). Barren stream bed occupies about 21 percent of alternative borrow removal area P-1.

3.2.2 Clear Site

The classification and description of the vegetation at the Clear Site (Clear AFS property and Bear Creek location) was based on analyses of aerial stereographic photos taken by the Alaska Railroad in 1989 (Alaska Railroad, 1989), aerial infrared photos taken by NASA in July of 1980 (NASA, 1980), a walk through of the proposed area for the HAARP facility on the Clear site (M&E/H&N, 1992a,b), and communications with the Alaska Department of Natural Resources (ADNR, 1992). Wetlands were described and mapped using state wetlands maps (UAF, 1987), *National Wetland Inventory Maps* (USFWS, 1992a,b) and a walk through of the areas.

Clear AFS Property. The Clear AFS property is dominated by open conifer forests and with occasional scattered woodland conifer forests (M&E/H&N, 1992b). The forests are a secondary or early successional growth forest, estimated to be 40 to 50 years old, and a result of fire (M&E/H&N, 1992b; ADNR, 1992a). Wetlands at the Clear AFS property comprise a negligible proportion of the area, only occurring in a few previously used gravel pits (USFWS, 1992a). No wetlands exist near the proposed project areas on the Clear AFS property (USFWS, 1992a).

Bear Creek Location. The Bear Creek location is more heterogeneously vegetated than the Clear AFS property (Figure 3.2-1). About equal proportions of shrubs (48 percent) and conifer forest (48 percent) occur on the site. Herbaceous cover types account for the remaining area.

TABLE 3.2-2. PERCENTAGES OF WETLANDS AT POTENTIAL BORROW LOCATIONS[1] FOR THE GAKONA SITE AS COMPARED WITH TOTAL BORROW AREA

COVER TYPE	P-1		P-2		A-1		A-4		A-5	
	AREA	BUFFER[2]	AREA	BUFFER[2]	AREA	BUFFER[2]	AREA	BUFFER[2]	AREA	BUFFER[2]
Scrub-shrub										
Open low shrub	0	0	0	0	0	0	0	0	51	0
Emergent										
Herbaceous	0	0	0	0	8	2	0	7	1	3
Stream Bed	21	0	0	0	0	0	0	0	0	0
Fresh Water	0	8	0	0	6	<1	0	1	<1	0
Total Wetland	21	8	0	<1	14	2	0	8	22	3

[1] See Figure 2.3-4 for locations of potential borrow sites.

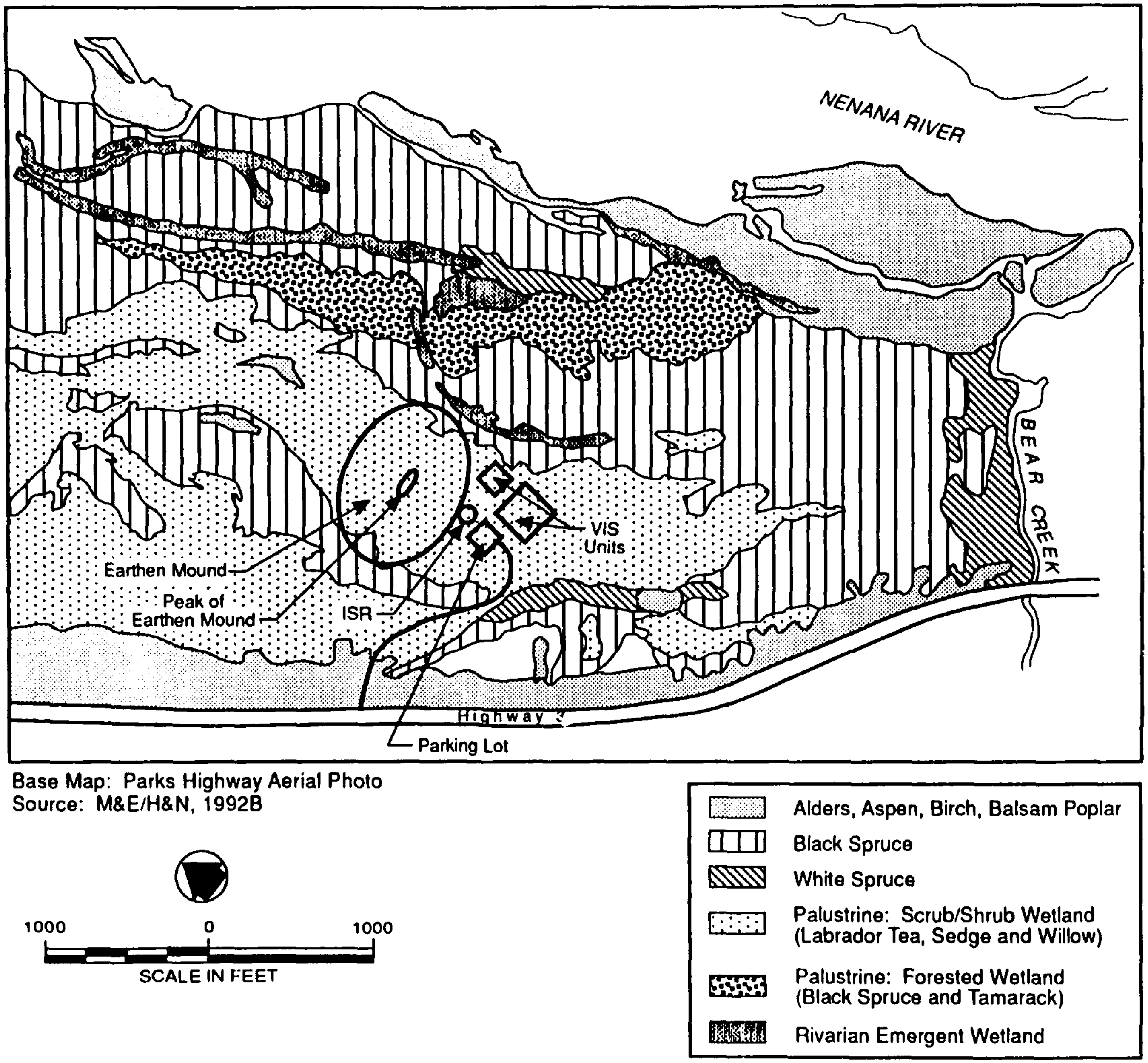


FIGURE 3.2-2. BEAR CREEK LOCATION VEGETATION COVER MAP

Primary trees include black spruce, white spruce, birch and aspen. Dominant shrubs include alder, willow, and labrador tea. Sedges comprised much of the ground cover.

Contrary to the Clear AFS property which is nearly devoid of wetlands, the majority (58 percent) of the Bear Creek location is wetlands (USFWS, 1992b). These wetlands include palustrine scrub/shrub (48 percent), palustrine forested (6 percent), and palustrine emergent (4 percent).

3.3 MAMMALS

This section describes the mammals and their habitats present within the alternative sites. Selected species of large and small mammals, mostly game animals or furbearers, are emphasized due to their ecological, regulatory, or recreational importance. For these species, general life history characteristics are summarized, their relative abundances are described, and the value of the habitats present on sites is evaluated.

3.3.1 Gakona Site

Mammalian information on the Gakona site was primarily obtained from the work conducted previously for the OTH-B project. Since the habitats on site and other conditions have changed little since that effort, the information obtained is still valid for use in this assessment.

3.3.1.1 General Habitat Description. The Gakona site is situated on a plateau located north of the Copper River. The Copper River Basin supports the taiga forest ecosystem described by Van Cleve et al. (1983). The site and surrounding area are dominated by open conifer forest (Section 3.2). Significant amounts of shrub habitat occur west of the site, in the vicinity of the numerous ponds and marshes, and to the northeast, in the vicinity of a large 45-year old burned area.

3.3.1.2 Species Descriptions.

Moose. Moose live throughout the boreal forests of North America. In interior Alaska, moose undergo regular seasonal migrations. Climatic conditions, particularly snow depth, strongly influence moose migration because of their effect on forage availability (Coady, 1982; LeResche et al., 1974). As winter progresses, moose gradually move from more open stands to denser cover (Krefting, 1974). Moose are likely to move into the area surrounding the Gakona site, particularly the burned area north of the site, during winter to take advantage of the available

browse. With the arrival of spring, most of these moose will disperse to summer areas located throughout the Gakona region.

Major habitat types important to moose in Alaska include areas with significant shrub growth. Early seral (intermediate) stages of plant succession, especially areas dominated by aspen, birch and willow, are preferred by moose (LeResche et al., 1974; Cushwa and Coady, 1976; Kelsall et al., 1977). These habitat types, including those created by fire, are key wintering areas in much of Alaska (Coady, 1982). As the vegetation becomes more mature, the quality of the habitat for moose decreases.

The Gakona site provides relatively poor winter moose habitat as compared to the 45-year old burned area, northeast of the site (ADFG, 1987a; 1987b). Small, shallow lakes west of the site provide suitable habitat and forage (aquatic vegetation) for moose in the spring and summer (ADFG, 1987a). These areas have a greater abundance of willow than does the Gakona site. Willow is a preferred food of moose (Peek, 1974; Hjeljord et al., 1982). A majority of the moose counted during the ADFG 1987 aerial surveys were located within the lake and pond system west of the site (ADFG, 1987a). During the ADFG surveys, 16 moose (0.23 moose/mi^2) were observed in the entire search area during the first survey and 28 moose (0.4 moose/mi^2) were observed during the second survey. These are minimum population estimates due to sub-optimum census conditions and are only applicable for the late winter (February-March) period.

In 1987, the Gakona site produced an estimated 1,300 to 2,600 lb/mi^2 of annual winter forage dry weight (AEIDC, 1988b). The non-burned portions of the surrounding area are likely to provide similar levels of available browse. Assuming a utilization rate of about 50 percent, Hubbert's (1987) carrying capacity model estimates winter moose densities of 1.3 to 2.6 moose/mi^2 (AEIDC, 1988b), which exceeds the density observed during the ADFG surveys. Carrying capacity can also be estimated using information on average consumption rates (M&E/H&N, 1989b). This approach yielded winter moose densities of 0.6 to 1.2 moose/mi^2, which are lower than the values obtained from the model.

Caribou. Caribou are gregarious, migratory animals of the northern taiga and tundra. In Alaska, there are 22 relatively discrete caribou herds which utilize specific wintering ranges, summering ranges, and migration routes. Only two of these caribou herds, the Nelchina and Mentasta, are likely to frequent the Gakona site and surrounding area.

In general, food availability is primarily responsible for the movements and migrations of caribou (Miller, 1982). Caribou eat a variety of plants but prefer lichens, mushrooms, woody browse, and leaves. The area surrounding the Gakona site, but generally not the site itself, has an abundance of cover types that contain such forage plants, and therefore, could potentially be used by Nelchina and Mentasta caribou.

ADFG (1987c) has documented infrequent use of the Gakona site by the Nelchina herd. In a study entailing 2,651 relocations of 85 radio-collared Nelchina caribou, only six radio-collared caribou ranged into the general vicinity of the Gakona site during the 1984 spring migration. No caribou were relocated near the project site during the summer or winter periods. Some animals from the Mentasta caribou herd may also cross the project area during migration, but this has not been confirmed (ADFG, 1987d). Several caribou were also observed on the site during May 1991 (M&E/H&N, 1991a).

Black Bear. Black bears are found throughout much of Alaska (Jonkel, 1978). Principal foods are berries, nuts, tubers, insects and their larvae, small mammals, eggs, carrion, fish, and garbage (Pelton, 1982). Individual and seasonal diets depend greatly upon availability of particular food items. Black bears prefer dense cover and use downed trees, escarpments under tree roots, and hollow logs for denning (Jonkel, 1978). Black bears hibernate in dens from October through April. One black bear was observed east of the property along the Tok Cut-Off Highway during the summer of 1991 (M&E/H&N, 1991b).

The Gakona site and surrounding area, although providing sufficient food, provides marginal black bear habitat because of the lack of cover and denning sites (ADFG, 1987a). Black bear densities on the site and surrounding area appear to be low (ADFG, 1987a). ADFG (1981)

estimated black bear densities on the Kenai Peninsula at 1 to 2 mi^2/bear and ADFG (1987a) cited a bear density of 4.5 mi^2/bear for the upper Susitna River area. These densities probably exceed that on the Gakona site and surrounding area because of the relatively poor habitat in the project vicinity. Only 5 black bears have been legally harvested in the ADFG Uniform Coding Units (encompassing over 1,800 mi^2) surrounding the Gakona site during 1961-1987, which is low compared with some other areas (ADFG, 1987e).

Brown Bear. Brown bears are found throughout northwestern Canada and Alaska (Jonkel, 1978; Craighead and Mitchell, 1982). Principal foods are fish, carrion, berries, grubs, and forbs. Brown bears prefer dense cover and generally excavate their dens in areas with steep slopes and porous soils (Craighead and Mitchell, 1982). Brown bears, like black bears, hibernate for about 7 months. Brown bears have home ranges of 10-50 mi^2. Brown bear densities in interior Alaska generally range between 15 mi^2/bear to 63 mi^2/bear (Miller and Ballard, 1982; ADFG, 1976; 1980).

The sparse cover of the Gakona site provides relatively poor brown bear habitat. The Gakona and Copper Rivers support salmon populations, but few bears have been observed fishing in the vicinity of the site. Fall use of the site and surrounding area is probably limited to resident bears in the areas west of the site and transient bears (ADFG, 1987a). Some spring use may occur around the lakes and muskeg west of the site as bears seek early-sprouting vegetation and berries which have persisted through the winter. No known den sites are present on the site or surrounding area. Black spruce stands, such as those present on the site, generally provide poor habitat for brown bears (ADFG, 1987e). Brown bear densities in and around the Gakona site are probably lower than: the 13.7 mi^2/bear observed in the Susitna River study area (cited by ADFG, 1987b); Gasaway et al.'s (1983) estimate of about 25 mi^2/bear for the eastern foothills near Tok; or Miller and Ballard's (1982) reported density of 16 mi^2/bear for the Nelchina Basin caribou calving area. The poorer habitat of the Gakona site, as compared to the areas cited above (AEIDC, 1987a), is thought to be the reason for the lower densities. ADFG reports that only 7 brown bears have been legally harvested in the ADFG Uniform Coding Units surrounding the Gakona site during 1961-1987 (ADFG, 1987e).

Gray Wolf. Gray wolves were once distributed throughout North America but are presently limited to a few northern states in the contiguous United States, and Alaska and Canada. Wolves are probably not dependent upon a particular habitat type but rather are limited by the distribution of their prey species and by man (Paradiso and Nowak, 1982). Wolves typically use well-drained areas near the center of their territories as den sites from April to June. Rendezvous sites, in similar habitats, are the center of activity from July to August. None of the packs known to use the Gakona region have den or rendezvous sites located within the Gakona site or surrounding area (ADFG, 1987b).

Wolves hunt in packs and primarily prey upon moose and caribou. Seventy percent of the wolf kills observed in the Nelchina Basin were moose and 21 percent of the kills were caribou (Ballard et al., 1987). Gasaway et al. (1983) reported a wolf density of about 24 mi^2/wolf in the Tanana Flats, 30 mi^2/wolf in the eastern foothills near Tok, and 23 mi^2/wolf in the western foothills near Denali during 1975. Wolves seldom exceed densities higher than 16 mi^2/wolf (Mech, 1974). Densities are probably lower now because of the extensive wolf control programs which have been implemented in the area (Gasaway et al., 1983; Van Ballenberghe, 1985; Ballard et al., 1987; Bergerud and Ballard, 1988).

Three wolf packs, each consisting of between 5 and 8 members, have territories which overlap the Gakona site (Ballard et al., 1987; ADFG, 1987b). There are also several other packs which have territories that abut, but do not overlap, the area surrounding the Gakona site (ADFG, 1987b). Wolf use of the Gakona site is probably greatest during winter when moose are most likely to frequent the area (AEIDC, 1987b). The tracks of a 4 to 6 member pack were observed during the ADFG Winter 1987 aerial surveys.

Small Furbearers. The site and surrounding area provide suitable habitat for red fox, coyote, lynx, marten, muskrat, and ermine. Beaver, river otter, wolverine, and mink may also occasionally occur in the area. Aquatic species (river otter, muskrat, and beaver) are probably limited to areas west of the site, where ponds and emergent wetlands are abundant. No empirical data on furbearer abundance or distribution on the Gakona site are available. Densities

of all furbearers are expected to be low (ADFG, 1987e) because of the generally poor productivity of the available habitat. During the aerial surveys (ADFG, 1987a), tracks of lynx and marten were observed, as was muskrat sign and a single coyote.

Other Species. In addition to the large mammals and furbearers described above, other mammalian species would be expected to utilize the Gakona site. These include shrews (e.g., arctic shrew), ground squirrels (e.g., arctic ground squirrel), lemmings, voles, and snowshoe hare. Quantitative data on the densities of these species on the Gakona site are unavailable.

3.3.1.3 Borrow Areas. Potential borrow areas along the Copper River are dominated by open conifer and closed deciduous forests with moderate proportions of shrub habitats (Section 3.2.1). The shrub habitats, particularly the riparian willow stands, present on the borrow areas provide high quality winter moose forage. Such riparian habitats often exist in a semi-permanent early successional stage because they are frequently disturbed by river action (Van Cleve and Viereck, 1981) and therefore provide long-term, quality winter moose habitat. Other species that may use these areas are black bear (cover), brown bear (cover), beaver (food), and snowshoe hare (food, cover). The proximity to the river, with its associated fish populations, predisposes these areas to use by bears.

The borrow area A-1 is also likely to be a relatively important source of browse for moose and snowshoe hare because it has larger quantities of shrubs as compared to the other alternate sites. In addition, all of the alternates except A-1 have a high proportion of deciduous trees which provide both cover and forage for moose, snowshoe hare, and beaver, cover for black and brown bear, and nesting sites for raptors. Alternatives A-1 and A-4 have high proportions of open conifer forests which are generally of less value to most wildlife. Alternative A-1 may be used by waterfowl more than the others because of the greater proportion of wetlands in these areas.

3.3.2 Clear Site

The following section discusses potential uses by mammals that could occur in the vicinity of the Clear AFS property and the Bear Creek location. State of Alaska Game Management Unit (GMU) areas 20A and 20C incorporate the sites. GMU area 20A extends east of the Nenana River and includes the Clear AFS property. GMU area 20C extends west of the Nenana River and includes the Bear Creek location (Figure 2.3-5). Much of the information below was obtained from the Alaska Department of Fish and Game (ADFG, 1992a,b,c). The following discussion begins with a general description of the habitats on the Clear AFS property and the Bear Creek location followed by descriptions of selected species of large and small mammals, mostly game animals or furbearers, that are emphasized due to their ecological, regulatory, financial, or recreational importance.

3.3.2.1 General Habitat Description. The potential locations for the HAARP facilities on the Clear AFS property are almost entirely uplands (see Section 3.2 Vegetation and Wetlands). These uplands are dominated by a young mixed conifer deciduous forest. The potential location for the ISR at the Bear Creek location is almost entirely composed of a palustrine scrub/shrub wetland dominated by labrador tea, willow, and sedge. The areas surrounding the Bear Creek location contain varied amounts of deciduous and conifer forests.

3.3.2.2 Species Descriptions

Moose. The young mixed deciduous conifer forest of the Clear AFS property and the Bear Creek location (see Section 3.2) provides good quality habitat for moose which spend both winter and summer in the area (ADFG, 1992a). Evidence of moose (tracks, browsing and droppings) was seen during a walk through the potential area for the IRI on the Clear AFS property and the Bear Creek location (M&E/H&N, 1992a,b). Moose densities in the area reportedly range from low to relatively high, 0.5 to 2 moose per square mile (ADFG, 1992b).

Caribou. The caribou living nearest the sites are the Delta and Denali herds. The Delta caribou herd is primarily located approximately 40 to 50 miles to the southeast in the Alaska Range between the Nenana River and the Delta River in GMU 20A (ADFG, 1992a and b). In recent years, however, the herd has spent portions of the winter in the Tanana Flats to the distance east of the Clear AFS property (ADFG, 1992a). The Delta caribou herd population has declined from a historic high of about 11,000 caribou in 1989 to a currently estimated population of 6,000. A combination of predation and weather, resulting in higher adult mortality and lower survival of calves, is thought to be responsible for the decrease in the caribou population (ADFG, 1992a). Due to the decline in the population, there was no 1992 caribou hunting season. The Denali caribou herd primarily ranges south and west of the Clear AFS property and the Bear Creek location in Denali National Park. Hunting of the Denali caribou herd has not been allowed in over 10 years (ADFG,1992b).

Caribou do not typically reside in the vicinity of the Clear AFS property and Bear Creek location areas (ADFG, 1992a) although caribou tracks were observed at the June Creek rest area (located approximately one-half miles south of the Bear Creek location). The tracks headed toward the Nenana River and the railroad tracks north of the Browne stop (Figure 2.3-6) (M&E/H&N, 1992b). According to the U.S. Fish and Wildlife Service (USFWS, 1992b) potential caribou habitat exists in area surrounding the sites, but the animals generally remain in the foothills north of the Alaska Range in the Ferry and Healy area and do not typically venture as far north as Clear AFS (ADFG, 1992c).

Black Bear. Black bears are common in the vicinity of the Clear AFS property and the Bear Creek location where moderately good habitat exists. A potential black bear den in the location of the proposed IRI was observed to be vacant during a walk through in October, 1992 (M&E/H&N, 1992b). Black bear densities probably range from 1 bear per 3 to 5 square miles (ADFG, 1992a).

Brown Bear. The Clear AFS property and the Bear Creek location provide moderately good habitat for brown bears. Brown bears are less common than black bears in the vicinity of the

Clear AFS property and the Bear Creek locations (ADFG, 1992b). The estimated density of brown bears in the vicinity of the Clear AFS property and the Bear Creek location is about 1 bear per 75 square miles (ADFG, 1992b). This density is less than the reported brown bear densities in interior Alaska that generally range between 1 brown bear per 15 to 63 square miles (Miller and Ballard, 1982; ADFG, 1976; 1980). Higher densities, 1 brown bear per 35 square miles, are found in the Alaska Range to the south (ADFG, 1992b).

Gray Wolf. Gray wolves likely use the Clear AFS property and Bear Creek location for hunting. The amount of use each received, would likely be dependent upon the numbers of moose using the sites. Gray wolf densities were estimated to be about 1 wolf per 25 square miles in GMU 20A in the Fall of 1991 (ADFG, 1992b).

Small Furbearers. Furbearers found in the vicinity of the Clear AFS property and Bear Creek location include: red fox, coyote, wolverine, mink, lynx, marten, beaver, muskrat, river otter, snowshoe hare, red squirrels, short-tail weasels, least weasels (ADFG, 1992a, b). Evidence of snowshoe hare was observed during a walk through of a potential area for the IRI on the Clear AFS property (M&E/H&N, 1992a). According to ADFG, there is no data available on abundances of these furbearers in the area (ADFG, 1992a, b).

Other Species. In addition to the large mammals and furbearers described above, numerous other mammalian species typical of taiga ecosystems would be expected to utilize the Clear AFS property and the Bear Creek location. Some of these likely include shrews (e.g., arctic shrew), ground squirrels (e.g., arctic ground squirrel), lemmings, and voles. The densities of these species are unknown (ADFG, 1992a, b).

3.4 BIRDS

This section describes the birds potentially affected by the HAARP facility. Bird migration patterns and flight behavior were extensively studied during 1987-1989 for the OTH-B ARS project (M&E/H&N, 1989b; ABR, 1991). The results of these studies were used extensively in this document. Additional sources of information included the U.S. Fish and Wildife Service (USFWS), Alaska Department of Fish and Game (ADFG) and site visits.

Much of the flight behavior recorded in the 1987-1989 studies (M&E/H&N, 1989b; ABR, 1991) can be considered to be largely non-site specific. These behaviors include altitude of flight and the effects of weather on flight behavior.

Flight Altitude. The maximum height of the HAARP IRI antenna elements would not exceed about 80 feet above ground level (agl) and the VIS would not exceed about 100 feet agl. The percentage of daytime birds observed, by species group, flying above 100 feet agl were calculated to characterize the bird flight altitudes relative to the proposed facility structures. During nighttime hours, radar and night-vision scope observations were used to characterize flight altitudes. The radar unit was incapable of measuring the flight altitude of bird flocks flying at altitudes less than 100 feet agl, due to the effects of ground clutter. Thus, night-vision scope observations were utilized to document the number of nighttime flights that occurred below 100 feet agl.

Daytime flight altitudes were generally similar between spring and fall migrations for all species groups (Table 3.4-1). During daytime, passerines (song birds) and shore birds flew above 100 feet agl about 59 percent of the time. This percentage might be considered conservative since concurrent radar observations suggest that the proportion of birds (especially smaller birds) flying at lower altitudes is probably overestimated relative to those flying at higher altitudes by the visual observation techniques used during daylight hours.

TABLE 3.4-1. DAYTIME FLIGHT ALTITUDES AT THE GAKONA SITE, 1987-1989

	Percentage Above 100 Feet AGL								
	Spring				Fall				
Species Group	1987	1988	1989	Total	1987	1988	1989	Total	Both Seasons
Waterfowl	76.4	89.5	86.8	87.3	86.6	96.1	88.3	92.1	88.2
- Ducks	63.9	94.7	91.7	89.3	95.3	100.0	96.6	98.7	90.1
- Geese	89.5	99.9	96.2	97.7	100.0	100.0	100.0	100.0	98.1
- Swans	84.9	86.1	84.9	85.5	85.7	95.2	87.4	90.9	86.6
- Trumpeter	34.9	92.7	87.5	88.5	53.1	79.9	86.0	77.0	84.8
- Tundra	98.5	94.3	65.0	80.3	100.0	100.0	100.0	100.0	87.6
Raptors	74.2	78.1	80.3	78.1	70.4	83.9	66.2	73.9	76.4
Shorebirds	13.0	78.3	61.9	59.1	93.3	11.1	0.0	57.7	59.0
Passerines	33.3	6.7	62.2	60.0	55.3	65.2	52.3	57.8	59.2

Total sample sizes (both seasons combined); Waterfowl (32,700); Ducks (6,366); Geese (2,067); Swans (23,518); Trumpeter Swans (2,000); Tundra Swans (2,672); Raptors (1,857); Shorebirds (368); Passerines (10,379).

Of the ducks observed during daylight hours, 90.1 percent flew above 100 feet agl while 98.1 percent of the geese flew above this altitude (Table 3.4-1). The majority of swans (86.6 percent) flew above 100 feet agl. Tundra swans flew slightly higher than trumpeter swans, with 87.6 percent of tundra swans flying above 100 feet agl versus 84.8 percent for trumpeter swans. This difference in flight altitude between these two species of swans is due to a higher proportion of local movements by trumpeter swans, common breeders in the Gakona region, which tend to be at lower altitudes than migratory movements. Raptors (birds of prey) as a group were observed flying over 100 feet agl about 76.4 percent of the time.

Nighttime flight altitude distributions, obtained from vertical radar observations in 1989, are shown on Figure 3.4-1. Altitude distributions were generally similar between spring and fall, with the largest number of targets observed in the 300 to 499 foot altitude category during both seasons.

Night-vision scope observations were conducted during the spring of 1989 and in the fall of 1988 and 1989. Observations ranged from 0.08 birds per hour to 0.3 birds per hour.

Using data from both radar and night-vision scope sampling (1989 only), the proportion of nighttime flights occurring below 100 feet agl was estimated at 0.5 percent for Spring 1989 and 6.8 percent for Fall 1989 (ABR, 1991).

Weather Effects. Birds generally migrate more during fair weather than during poor weather conditions (Richardson, 1978). Migration rates during daylight hours for swans were generally much lower during periods of precipitation than during periods without precipitation. The pattern for birds of prey was similar, with rates lower during poor weather. Songbirds showed the exact opposite trend, with migration rates generally highest during poor weather periods.

Weather conditions are known to affect the flight altitude of birds. In general, daytime migrants will fly lower when there is poor visibility, dense cloud cover accompanied by low cloud ceilings, or precipitation, and also when flying into strong headwinds (Gauthreaux, 1978).

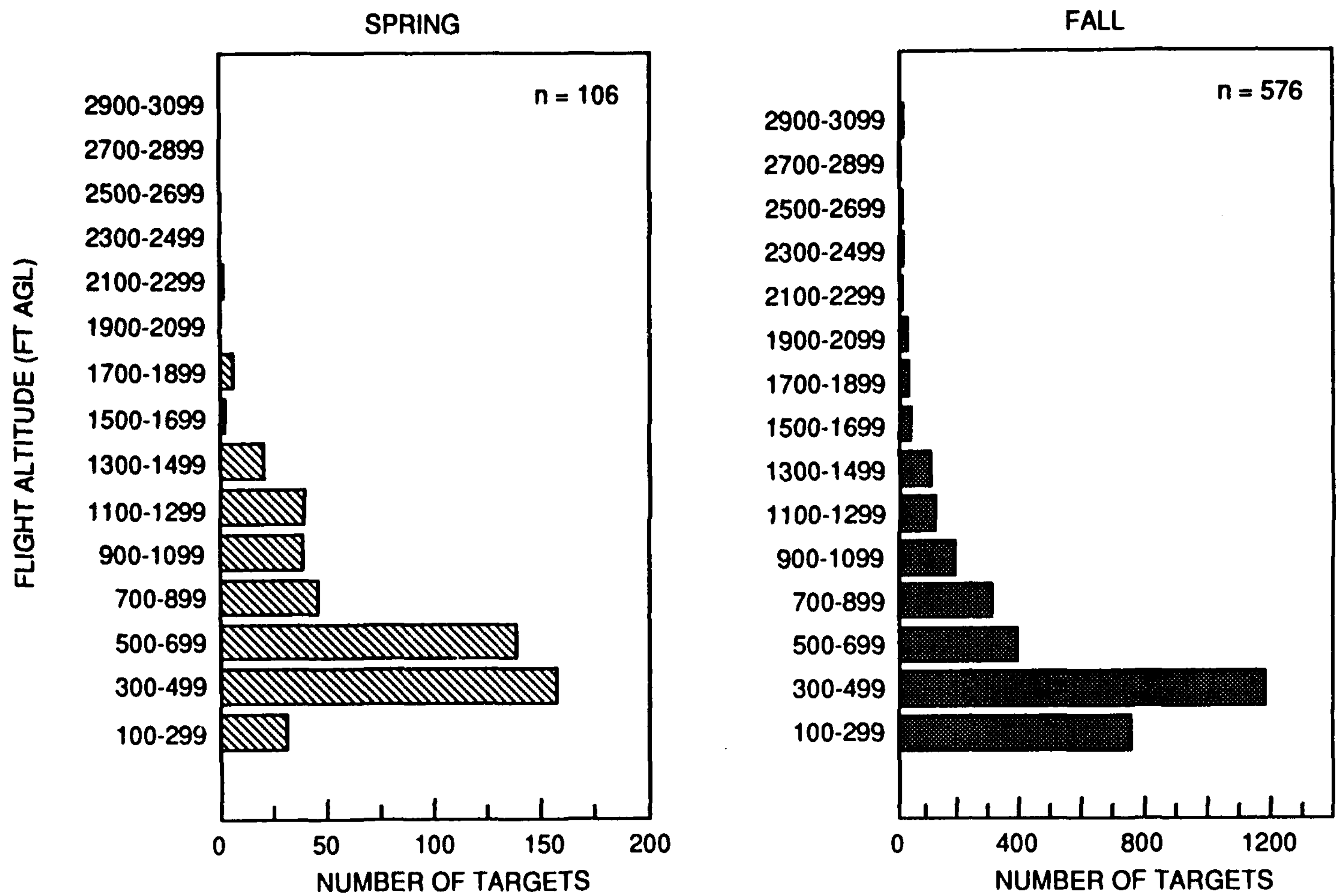


FIGURE 3.4-1. DISTRIBUTION OF NIGHTTIME AND TWILIGHT FLIGHT ALTITUDES OF TARGETS DETECTED BY VERTICAL RADAR (CORRECTED FOR SAMPLING AREA) AT THE GULKANA SITE, ALASKA, DURING SPRING AND FALL, 1989

During daylight hours, swans, birds of prey, and songbirds flew higher during periods of high (>3000 feet agl) cloud ceilings than during periods of low (<3000 feet agl) cloud ceilings. During the period from 1968-1987, cloud ceilings in the Gakona region dropped below 3000 feet agl 9.4 percent of the time in spring (April and May), and 21 percent of the time in the fall (September and October) (AEIDC, 1988c). Cloud ceiling heights were particularly low during October (<3000 feet agl, nearly 28 percent of the time) when large numbers of swans migrate through the Gakona region.

Precipitation had little effect on pushing daytime flight altitudes below 100 feet agl for songbirds (spring and fall) and swans (fall only). Birds of prey flew lower during periods of precipitation in both spring and fall, as did swans in spring. During the period from 1968 to 1987 in the Gakona region, precipitation (fog, rain, snow, or hail) occurred about 8 percent of the time in spring (April and May) and nearly 19 percent of the time in the fall (September and October), with the highest levels occurring during October (23 percent) (AEIDC, 1988c).

Daytime flight altitudes for swans were generally highest when winds (as measured from ground level) exceeded 10 miles per hour (mph), regardless if they were headwinds, tailwinds, or crosswinds, except in fall when flight altitudes were lowest when headwinds exceeded 10 mph. It should be noted that winds aloft could have differed from those measured at ground level. Birds of prey generally flew highest during tailwind or calm periods; the lowest altitudes occurred when headwinds or crosswinds exceeded 10 mph. Songbirds generally flew highest during calm or tailwind conditions and lowest during headwind conditions or when crosswinds exceeded 10 miles per hour.

3.4.1 Gakona Site

Bird migration patterns at the Gakona site were quantified using data from the extensive site-specific studies of 1987-1989 spring and fall migrations for the OTH-B ARS project (M&E/H&N, 1989b; ABR, 1991). Information such as species composition, breeding birds numbers, and migratory rates are generally specific to the Gakona site.

3.4.1.1 Species Composition. A total of 119 species of birds were identified at the Gakona site during 1987-1989 avian studies (Table 3.4-2). The number of birds observed during daylight hours was generally higher in spring than in fall for all species groups (Table 3.4-3). Swans were most abundant during all seasons, followed by ducks and passerines. Shorebirds were least observed, but this was probably due to their nighttime migratory behavior (M&E/H&N, 1989c).

3.4.1.2 Migration Patterns. Birds migrating into and out of Alaska tend to follow coastlines or major river drainages through mountainous areas. The Gakona site lies within the Copper River Basin, which is one of Alaska's more important migration corridors (Gabrielson and Lincoln, 1959; King and Lensink, 1971). The Copper River Basin corridor is used primarily by birds of the Pacific Flyway. Many birds using the Copper River corridor in spring follow the Pacific Flyway north from points along the coast until reaching the Copper River Delta, an important staging area for birds migrating through the Gulf of Alaska region (Isleib and Kessel, 1973). From this area, only a small proportion of birds that stage at the delta fly north up the Copper River through the Chugach Mountains to reach the Nelchina Basin. Most of the migration up the Copper River Basin is probably of birds nesting in the Nelchina Basin and migration beyond this area is probably minimal. Kessel et al. (1982) reported that the nearby Upper Susitna Basin was not a major migratory pathway for waterbirds, probably because water bodies in the area are typically frozen at the time of spring migration.

Migratory movements between the Copper River Basin and the Upper Tanana River Valley are not well documented although at least some birds move from the Upper Tanana River Valley into the Upper Copper River Basin and the Nelchina and Susitna Basins through passes in the eastern Alaska Range. Some species, such as the tundra swan, may continue past these basins to breeding areas in western Alaska (ABR, 1988).

Swans migrating through the Gakona-Glennallen region of Alaska generally follow a minor migration route oriented approximately southwest to northeast and stretching from the Tanana River Valley to the Nelchina Basin and beyond. A second minor migration route runs north and

TABLE 3.4-2. BIRD SPECIES OBSERVED AT THE GAKONA SITE AND SURROUNDING AREA, 1987-1989

Species Group	Total Species	Most Abundant Species Observed From Primary Station (in order of abundance within group)					
		1987		1988		1989	
		Spring	Fall	Spring	Fall	Spring	Fall
Ducks	17	Northern pintail	Red-breasted merganser	Northern pintail	Northern pintail	Northern pintail	Red-breasted merganser
Geese	3	Canada goose	[1]	Canada goose	Canada goose	Canada goose	Canada goose
Swans	2	Tundra swan Trumpeter swan	Trumpeter swan Tundra swan	Trumpeter swan Tundra swan	Trumpeter swan Tundra swan	Trumpeter swan Tundra swan	Tundra swan Trumpeter swan
Eagles/Hawks	8	Bald eagle Northern harrier	Northern harrier Bald eagle	Bald eagle Northern harrier	Rough-legged hawk Bald eagle	Bald eagle Northern harrier	Bald eagle Northern harrier
Falcons	4	Merlin	Merlin	Merlin	Merlin	American kestrel	Merlin
Owls	5	Great-horned owl	Northern Hawk-owl	Short-eared owl	[1]	Great gray owl	Northern hawk-owl
Shorebirds	12	Lesser yellow-legs	Long-billed dowitcher	Lesser yellow-legs	Common snipe	Lesser yellow-legs	[1]
Passerines	52	Bohemian waxwing Redpoll Common raven Lapland Longspur American robin	American robin Water pipit Dark-eyed junco Pine grosbeak Gray jay	Lapland longspur American robin Common raven Snow bunting White-winged crossbill	Common raven Redpoll spp. Gray jay Pine grosbeak American robin	American robin Lapland longspur Rusty blackbird Common raven Redpoll spp.	Pine grosbeak Common raven Redpoll Gray jay American robin
Other	15	Bonaparte's gull	Sharp-tailed grouse	Spruce grouse	Spruce grouse	Arctic tern	Sharp-tailed grouse
Total Species	118						

[1] No birds identified to the species level for this group during this season.

TABLE 3.4-3. NUMBER OF BIRDS OBSERVED FROM AN OBSERVATION POINT ADJACENT TO THE GAKONA SITE, 1987-1989

	NUMBER OF BIRDS					
	1987		1988		1989	
Species Group	Spring	Fall	Spring	Fall	Spring	Fall
Waterfowl	2,266	933	14,062	2,975	10,659	1,854
- Ducks	780	63	3,762	362	1,282	118
- Geese	134	3	978	230	683	60
- Swans	1,263	853	8,907	2,383	8,440	1,676
- Trumpeter	63	168	913	322	377	157
- Tundra	137	126	710	625	924	250
Raptors	201	181	564	279	360	279
- Eagles/Hawks	186	160	526	249	336	206
- Falcons	9	9	7	7	13	14
- Owls	6	9	10	0	3	45
Shorebirds	69	15	147	9	127	2
Passerines[1]	444	897	912	599	675	628
Other	53	5	54	9	73	22
TOTAL	3,033	2,031	15,739	3,871	11,894	2,785
Sampling Time (Hours)	198	417	369	490	400	449

[1] Includes birds observed within 110 yards of station only.

south from the Gulf of Alaska to the Nelchina Basin, generally paralleling the Copper River (Figure 3.4-2) (ABR, 1991). Other species groups probably follow similar migration corridors. Bird movements observed during 1987-1989 avian studies conformed well to these patterns.

Ducks, geese, songbirds, and shorebirds are primarily nighttime migrants while birds of prey are mostly daytime migrants. Swans, especially tundra swans, often fly nonstop regardless of light conditions (AEIDC, 1987c). During spring migration, birds of prey were generally the first migrants observed, followed by geese and swans, ducks, songbirds, then shorebirds. Dabbling ducks generally arrived earlier than diving ducks. In the fall, shorebirds were the first migrants leaving Alaska, generally followed by songbirds, birds of prey, geese, ducks, and then swans. Dabbling ducks generally left earlier than diving ducks.

Nighttime migration was sampled with a mobile radar unit capable of a long range setting which sampled large birds or flocks at a distance or a short range setting which sampled all sized birds and flocks at close range. Nighttime spring migration rates, measured by long-range radar, increased in late April and were generally highest in mid-May. There were approximately 100 targets (a bird or flock of birds appearing on the radar screen) per hour in 1988 and 50 targets per hour in 1989. Fall migration, measured using long-range radar, was more pulse-like than in the spring. Distinct peaks occurred in early, mid, and late September and in early October. Fall peaks were in the range of 30 to 80 targets per hour.

Migration rates, based upon the results of short range radar, were generally low until the first week in May, when they peaked sharply at nearly 900 targets per hour, during the spring of 1988. Peak rates during daylight hours for songbirds occurred during this same general period. In 1989, the number of targets per hour increased gradually beginning in late April and peaked at approximately 400 targets per hour in mid-May. Nighttime peaks in 1989 corresponded with daytime songbird and shorebird movements.

Ducks. Daytime duck migration in spring generally occurred during the last week of April through the first week of May, with peak rates occurring around the first of May (15, 67, and

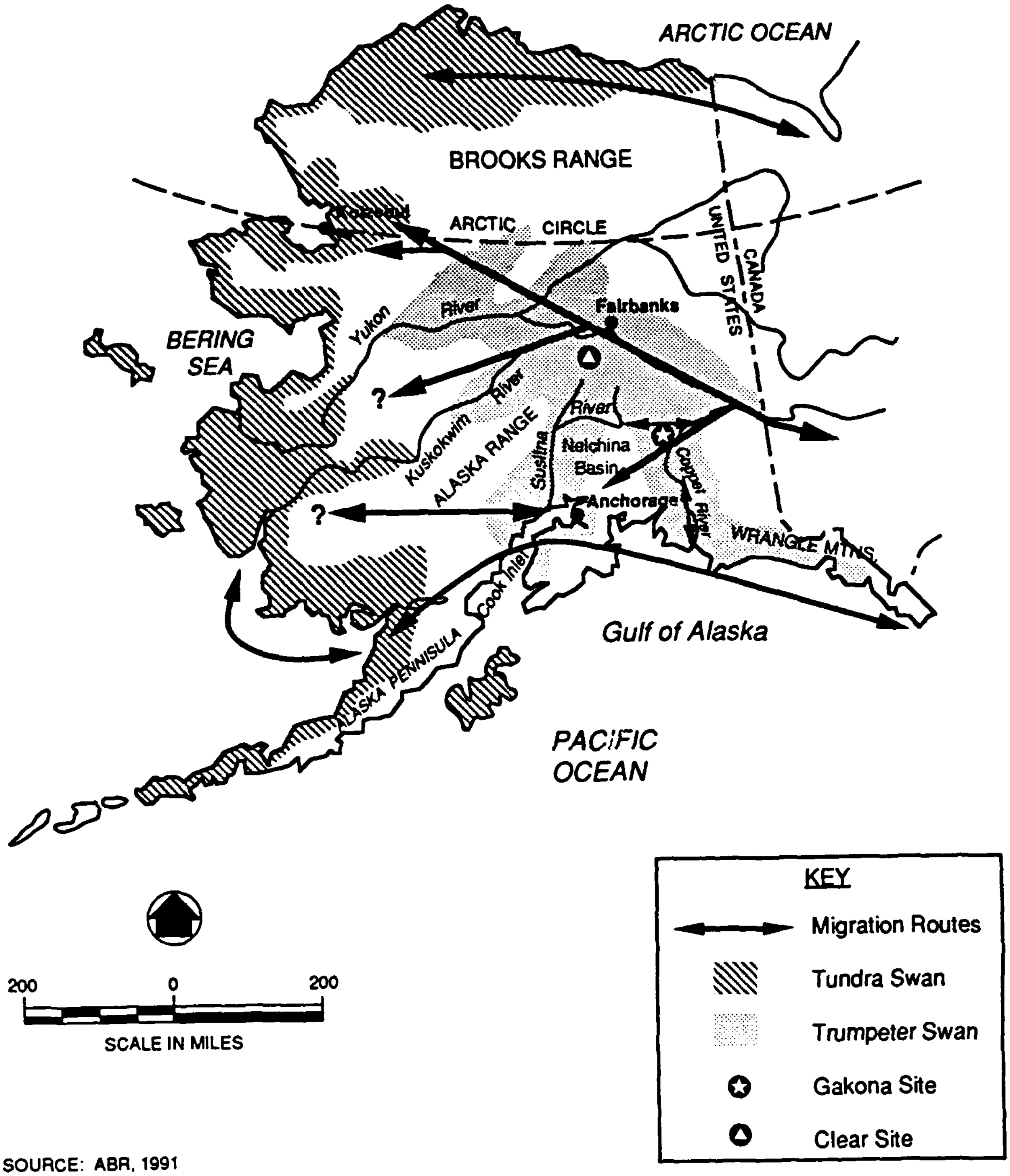


FIGURE 3.4-2 BREEDING RANGES AND POSSIBLE MIGRATION ROUTES OF TUNDRA AND TRUMPETER SWANS IN ALASKA

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16 birds per hour in 1989, 1988, and 1987, respectively). The number of ducks observed during aerial surveys gradually increased from the third week in April, as ducks began to arrive, until early to middle May, when they peaked. Peak numbers exceeded 5,000 birds in 1987 and 1988 and exceeded 4,000 birds in 1989. Numbers generally began to decline by 15 May.

Fall daytime duck migration was characterized by numerous peaks throughout September and October. Peak fall rates were 1 bird per hour in 1987, 7 birds per hour in 1988, and 4 birds per hour in 1989. Numbers of ducks observed during 1987 and 1988 aerial surveys were relatively constant at about 3,000 birds in September, as birds staged for migration, but rapidly declined in early October as open water became unavailable. In 1989, initial numbers were higher (approximately 5,000 birds through mid-September) and began decreasing in mid-September. This decrease was more gradual than in the two previous years and significant numbers (more than 1,500 birds) remained until mid-October. This was due to unusually mild weather which allowed open water to persist.

Geese. Spring migration of geese was mainly confined to the last two weeks of April during daylight hours. Peak rates were 4 birds per hour in 1987, 18 birds per hour in 1988, and 11 birds per hour in 1989. Fall migration was difficult to categorize as few geese were observed; daytime migration rates were much higher during spring.

Swans. In spring, daytime migration rates were highest for swans during late April, peaking sharply during this period at 34 birds per hour in 1987, 293 birds per hour in 1988, and 228 birds per hour in 1989. Numbers of swans, as observed during aerial surveys, also peaked sharply in late April at 400 to 1,000 birds before dropping off in early May to a relatively constant level of 100 to 150 birds. This decline probably represented locally breeding trumpeter swans.

Fall migration rates were low until early October and rose steadily to a sharp peak in mid-October (72 birds per hour in 1987, 93 birds per hour in 1988, and 65 birds per hour in 1989). Aerial surveys during fall showed a similar trend, with numbers of swans remaining relatively

constant at about 250 birds per hour during September and rising rapidly in early October to peak at 600 to 1,000 birds per hour. Numbers dropped off sharply by mid-October as freeze-up progressed and open water became unavailable.

Overall daytime rates of swan migration were considerably higher in spring than in fall. Peak daytime migration rates were about three times higher in Spring 1988 and 1989 than in the corresponding fall season; peak rates in Spring 1987 were difficult to compare with the other seasons because a number of days during the peak migration period were not sampled. Peak migration rates were similar between years during the fall season.

Shorebirds. Relatively few shorebirds were observed during daylight hours at the Gakona site, especially during the fall. Most of the shorebirds observed during spring migration were seen near the end of the study periods, in early to mid-May. Most shorebirds had probably already departed Alaska by the time fall observations commenced at the beginning of September. Those that remained after this date may have migrated at night.

Birds of prey. Birds of prey are early spring migrants and migration was already underway when observations began in mid-April. Daytime migration rates were relatively stable at 1 to 2 birds per hour during the spring studies. Fall migration was characterized by a constant low rate of migration, with peaks in late September/early October of between 2 and 3 birds per hour. Fall migration was more uniform in 1989 than during the other two fall seasons, with more constant migration rates and fewer and smaller peaks. Spring migration rates were about double fall rates during daylight hours.

Songbirds. Daytime songbird migration (within 110 yards of the observation station) in the spring was characterized by multiple peaks, with rates generally highest during late April and early May (peak rates of 9 birds per hour in 1987, 7 birds per hour in 1988, and 11 birds per hour in 1989). Fall migration also occurred in multiple peaks and rates during this season were generally highest in early to mid-September (9 birds per hour in 1987, 5 birds per hour in 1988, and 5 birds per hour in 1989) with smaller peaks in mid-October. The multiple peaks observed

during both seasons were largely due to different species within this group migrating at different times. Overall rates of daytime migration were higher in the spring (2.2 to 3.8 birds per hour) than in the fall (1.3 to 2.0 birds per hour). Peak rates were similar among seasons.

During the Fall 1988 migration, four distinct peaks were apparent during short-range radar observations. Two peaks were apparent in mid-September (310 and 370 targets per hour), one in late September (170 targets per hour), and one in mid-October (220 birds per hour). Migration rates were more consistent in 1989 but four periods of peak movement were also apparent. These occurred in late August (450 targets per hour), mid-September (325 targets per hour), late September (250 targets per hour), and early October (100 targets per hour). As with long-range radar, peak nighttime migration rates were higher in spring than during fall in 1988 but higher in fall than during spring in 1989.

3.4.1.3 Concentration Areas and Breeding Populations. Waterfowl concentration areas, swan and birds of prey nest sites, and trumpeter swan brood-rearing areas were located during periodic aerial surveys. Breeding songbird populations, which utilize forested upland and wetland habitats on the Gakona site, were determined by breeding bird censuses using the territory mapping method (Williams, 1936; IBCC, 1970).

Large concentrations of waterfowl resting, feeding, or staging on the Gakona site, or in the immediate vicinity of it, were generally uncommon. Only one area, a large lake just 1,000 feet northwest of the site boundary, was consistently used by high concentrations of waterfowl. The lake was heavily used by ducks and swans during all seasons except the Fall of 1989. Another smaller pond, within the northeast edge of the site boundary, was used by high concentrations of ducks and swans in Spring 1987 and Spring 1989.

Songbirds. Densities of breeding songbirds were highest in mixed forest, intermediate in low shrub, and lowest in black spruce forest habitats (Table 3.4-4). Mixed forests also had the highest number of breeding species (11), while low shrub habitats had the fewest (4). The

TABLE 3.4-4. BREEDING BIRD CENSUS RESULTS, SPRING 1987

Habitat Type	Number of Breeding Species	Density[1]	Breeding Species Diversity
Black Spruce Forest I	8	11.2	1.89
Black Spruce Forest II	9	12.6	1.97
Mixed Forest	11	16.1	2.18
Low Shrub	4	15.3	1.23

[1] Number of territories per 25 acres.

Source: ABR (1987).

Gakona site consists mostly of an open black spruce forest habitat. The songbird breeding densities and species composition on the Gakona site were, respectively, generally lower than, and similar to, those reported in other interior Alaska studies (Theberge, 1976; Spindler and Kessel, 1978; Kessel et al., 1982).

Ducks. Estimates of breeding ducks in the immediate vicinity of the Gakona site were 91 ducks per square mile in 1987, 82 ducks per square mile in 1988, and 91 ducks per square mile in 1989. These figures are two to three times higher than United States Fish and Wildlife Service estimates for the regional stratum containing the site (Conant and Roetker, 1987; Conant and Hodges, 1988; Conant and Dau, 1989), suggesting that the area in the immediate vicinity of the Gakona site contains an above average waterfowl habitat. However, the Gakona site, which is mostly covered with an open black spruce forest, is of low value to ducks relative to the area to the north and west, which contains numerous small lakes, ponds, and emergent wetlands.

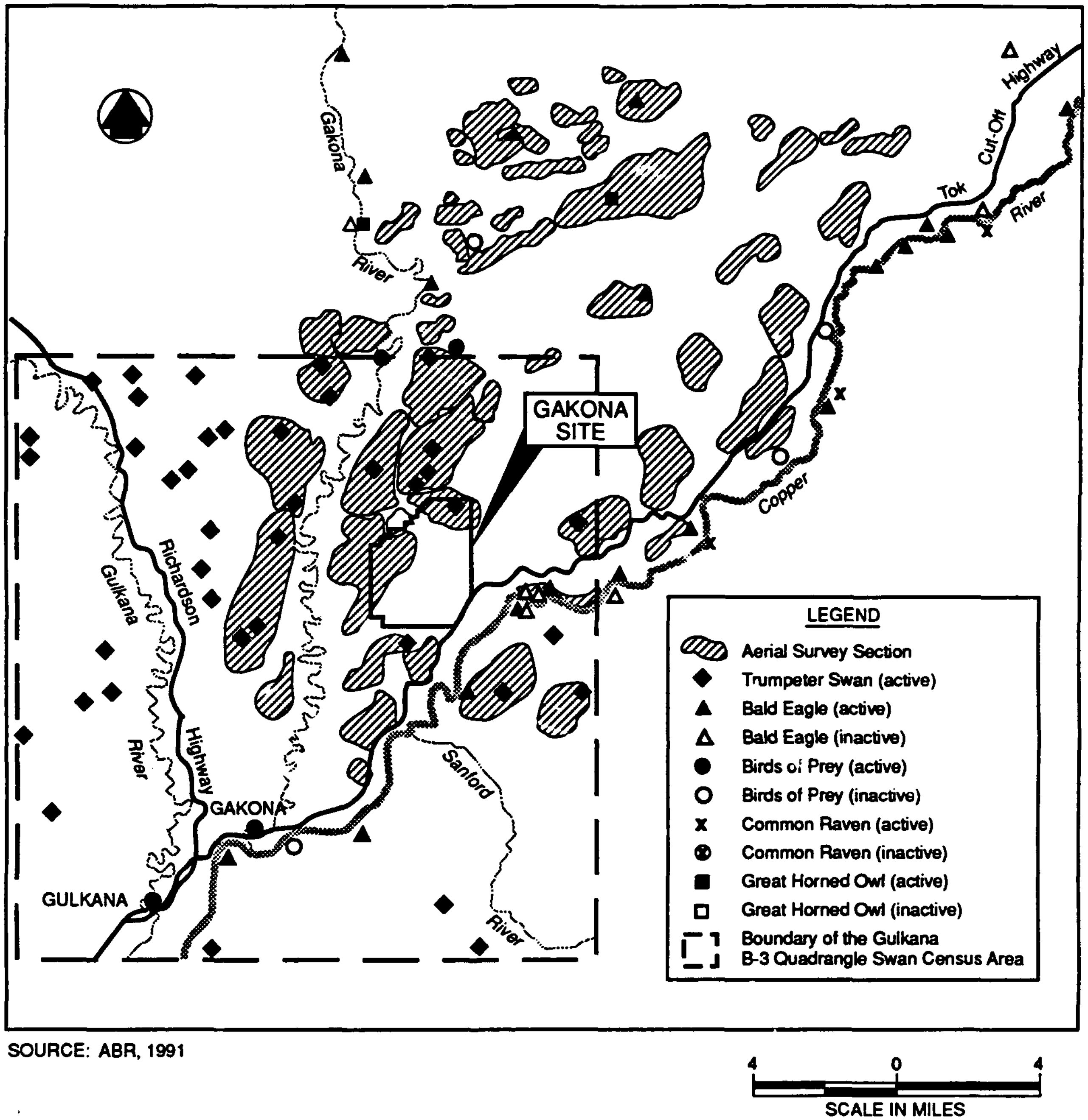
Trumpeter Swans. The Gakona-Glennallen region is a major breeding area for trumpeter swans (ABR, 1991). During aerial swan censuses of the Gulkana B-3 Quadrangle (Figure 3.4-3), which contains the Gakona site, a total of 25 nests and 97 swans were observed in 1987; 27 nests and 105 swans were observed in 1988; and 22 nests and 112 swans were observed in 1989 (Table 3.4-5). These data suggest that the well documented increase in the breeding trumpeter swan population in the Gakona-Glennallen region (King and Conant, 1981; Conant et al., 1985; Hodges et al., 1986; Hodges et al., 1987; ABR, 1991) may be leveling off.

Although the number of nesting trumpeter swans was higher west of the Gakona site (Figure 3.4-3), several nests were observed within or adjacent to the site boundary (Figure 3.4-4). Wetlands and ponds in the extreme northern and western portion of the site also received substantial use by trumpeter swan broods (Figure 3.4-4).

TABLE 3.4-5. COUNTS OF TRUMPETER SWANS DURING BREEDING AND BROOD-REARING PERIODS WITHIN THE GULKANA B-3 QUADRANGLE, 1969 - 1989

	1969	1975	1980	1985	1987	1988	1989
Nests	--	--	--	--	25	27	22
Total Swans (breeding survey)	--	--	--	--	97	105	112
Broods	1	2	2	14	19	17	18
Juvenile Swans (brood-rearing survey)	4	5	6	37	72	43	60
Total Swans (brood-rearing survey)	16	20	39	109	168	174	176
Mean brood size	--	--	--	2.6	3.8	2.5	3.3

-- No data
Source: ABR (1991)



SOURCE: ABR, 1991

FIGURE 3.4-3. LOCATIONS OF SWAN AND BIRDS OF PREY NESTS IN THE VICINITY OF THE GAKONA SITE, ALASKA, 1987-1989

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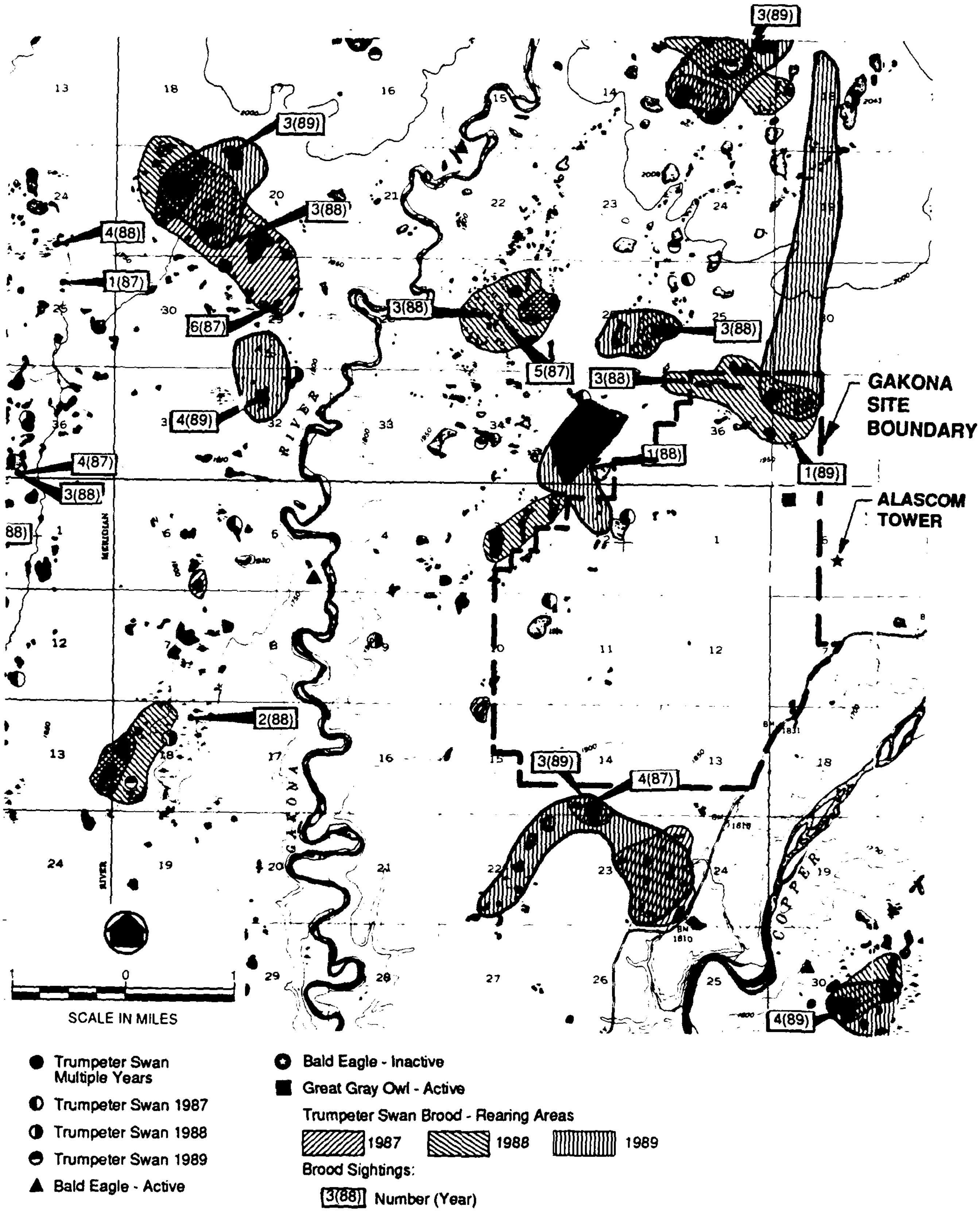


FIGURE 3.4-4. BIRD OF PREY AND SWAN NEST SITE LOCATIONS AND TRUMPETER SWAN BROOD-REARING AREAS NEAR THE GAKONA SITE

Birds of Prey. Nesting birds of prey were also quantified during aerial surveys. In 1987, a total of 20 bald eagle nests (4 active) were found, 25 were discovered (17 active) in 1988, and 28 (16 active) were discovered in 1989, although there was more extensive coverage during the 1988 and 1989 surveys (Figure 3.4-3). Most of these eagle nests were located along the Copper and Gakona Rivers; few were in upland locations. Active nests of great horned owls, great gray owls and red-tailed hawks were also discovered during aerial surveys. Only one bird of prey nest (great gray owl) was observed near the facility location.

3.4.1.4 Borrow Areas

A total of five borrow pit locations have been identified for possible use by the project (Figure 2.3-4). Five (one active) bald eagle nests were located on the edge of the P-1 borrow area. Two additional bald eagle nests (one active) were located within a mile of the east side of this pit. A trumpeter swan nest site, used during both 1987 and 1988, occurs less than one mile south of pit P-1. Additional swan brood-rearing areas exist about 1.5 miles northeast and 2 miles south of this location. Swan and duck concentrations were observed just south of pit P-2 during 1988 and at two locations approximately two miles south of pit P-2 in 1989. One inactive bird of prey nest and no swan nests were discovered in the immediate vicinity of pit A-1. A bald eagle nest, active in both 1987 and 1988, was found just to the south of pit A-5. One active bald eagle nest was located on the border of pit A-4 in the spring of 1989.

3.4.2 Clear Site

The use of the area by listed endangered or threatened bird species, bird migration patterns and flight behavior, and breeding waterfowl populations at the Clear site were assessed based on information obtained from communications with Clear AFS personnel (ADFG, 1992d; ABR, 1992), and government agencies (ADFG and USFWS), and through the use of existing information in currently available literature. No site specific bird field studies have been completed for the Clear site.

3.4.2.1 Species Composition. Most of the species documented above for the Gakona site would occur at the Clear site with varying abundances. Thirty-three species of migratory birds, 14 species of year-round residents, and 28 species of spring and fall transients have been observed at the nearby ADFG fish hatchery (ADFG, 1992d) (Table 3.4-6). In addition the USFWS has identified that two subspecies of peregrine falcon could occur on the site (USFWS, 1992d,e). These birds are addressed below under Section 3.4.2.4 Threatened and Endangered Birds.

3.4.2.2 Migration Patterns. The Clear AFS property and the Bear Creek location lie in the Nenana River valley, which is an important migratory route for waterfowl and other birds through the mountains of the Alaska Range (USFWS, 1992c). In addition, the Nenana River valley lies within the Tanana River Basin, one of Alaska's most important migration corridors (Gabrielson and Lincoln, 1959; King and Lensink, 1971).

The Clear site is located within the major migration route of sandhill cranes (Kessel, 1984). Large numbers of sandhill cranes could migrate through the project area, since thousands migrate through Ferry about 3 miles to the south (ABR, 1992). Open areas and alluvial islands of wide, braided riverbeds, such as found on the nearby Nenana River, are preferred as roosting sites by sandhill cranes (Kessel, 1984).

The U.S. Fish and Wildlife Migratory Management Survey has no data on the use of the Clear site area by waterfowl during the migration periods (USFWS, 1992f). However, a number of migratory species have been observed on Clear AFS (ADFG, 1992d). Large numbers of Canada geese have been observed to rest on the Clear AFS radar clearance zone during the fall and spring migration periods (FSI, 1992a).

3.4.2.3 Breeding Bird Populations. Information on breeding birds was obtained from the USFWS and ADFG. Information on breeding waterfowl was obtained from the results of aerial surveys conducted by the USFWS (USFWS, 1992f) during the month of May for over 35 years

TABLE 3.4-6. SPECIES OBSERVED AT THE CLEAR SITE

MIGRATORY SPECIES		
Canada goose	Bonaparte's gull	Glaucous-winged gull
Mew gull	Arctic gull	American golden plover
Black-bellied plover	Tundra swan	Trumpeter swan
Mallard	Northern pintail	Green-winged teal
Northern shoveler	American widgeon	Canvasback
Bufflehead	Golden eagle	Bald eagle
Marsh hawk	Merlin	Northern phallarope
Horned grebe	Greater scaup	Lesser scaup
Rusty blackbird	Pine grosbeak	American tree sparrow
Bohemian waxing	Surf scoter	Ring-necked duck
Oldsquaw	Red phallarope	
YEAR ROUND RESIDENTS		
Common raven	Gray jay	Black-capped chickadee
Boreal chickadee	Common redpoll	Hoary redpoll
Great horned owl	Hawk owl	Great grey owl
Boreal owl	Spruce grouse	Ruffed grouse
Willow Ptarmigan	Sharp-tailed grouse	
SPRING, SUMMER, AND FALL RESIDENTS		
American robin	Northern flicker	Hairy woodpecker
Downy woodpecker	American kestrel	Gyrfalcon
Sandhill Crane	American golden plover	Common loon
Arctic loon	Red-necked grebe	Horned grebe
Sharp-skinned hawk	Red-tailed hawk	Rough-legged hawk
Violet green swallows	Bank swallows	Tree swallows
Varied thrush	Fox sparrow	Slate grey junco
White-crowned sparrow	Yellow-rumped warbler	Dipper
Lesser yellow-legs		

Source: ADFG, 1992d

(Table 3.4-7). The nearest of these surveys are two east-west, 16 by 1/4 mile, segments (segments 52 and 53), located due north of the Clear site (Figure 3.4-5).

Trumpeter Swans. The Clear site is located within the breeding range of trumpeter swans (Figure 3.4-2). Nests and breeding trumpeter swans have been observed along segments 52 and 53 (Table 3.4-7). Evidently there is no swan use of the areas nearby the Clear and Bear Creek site during the summer (USFWS, 1992g).

Ducks. A variety of breeding ducks have been observed along aerial segments 52 and 53 (Table 3.4-7). The yearly average of ducks, observed during the latter part of May, along segments 52 and 53 was 29.2 and 24.5, respectively. The ducks listed in Table 3.4-2 occasionally breed in the area but were not observed in survey segments 52 and 53. The most common breeding ducks observed along the segments were mallard and northern pintail, northern shoveler, greater scaup, American widgeon, green-winged teal, and bufflehead.

Birds of Prey. A few bald eagle nests exist near Clear AFS property, but there are no known nests near the Bear Creek location (USFWS, 1992g). Bald eagle nests have not been observed along survey segments 52 and 53 (Table 3.4-7) since aerial surveying was begun along those segments in 1957 (USFWS, 1992g). An average of .03 breeding bald eagles have been observed during late May of each year along segment 52. Bald eagles have not been observed along segment 53. Breeding ospreys were not seen during any of the aerial surveys of segments 52 and 53, although they may make occasional use of the areas near the Nenana River (USFWS, 1992g).

3.4.2.4 Threatened and Endangered Birds. Two listed species, one endangered and one threatened, occur in the Clear site area (USFWS, 1992d). The endangered American peregrine falcon and the threatened arctic peregrine falcon migrate through the Clear site area during spring and fall migration. Timing of spring migration is from about mid-April to mid-May and, in fall, from about mid-August and mid-October (Roseneau et al., 1981).

TABLE 3.4-7. NUMBER OF BREEDING INDIVIDUALS OBSERVED DURING MAY ALONG SURVEY SEGMENTS 52 AND 53 FROM 1957 TO 1992

SPECIES	YEARLY AVERAGE [1] (Segment 52)	YEARLY AVERAGE [1] (Segment 53)
Mallard	7.17	1.89
Gadwall	0	0
American widgeon	2.81	1.61
Green-winged teal	1.61	O.97
Blue-winged teal	0	0
Northern shoveler	3.28	1.28
Northern pintail	6.61	3.94
Redhead	0	0
Canvasback	0.11	0.72
Greater scaup[2]	2.28	2.92
Ring-necked duck[2]	0.11	0.17
Goldeneye	0.33	0.28
Bufflehead	1.31	1.44
Old squaw	0.06	.25
Scoter	0.28	1.61
Merganser	0.06	0.11
White-fronted goose[2]	0	0
Canada goose[2]	0.58	0.33
Trumpeter swan[2]	0.94	0.64
Trumpeter swan nest	0.14	0.11
Arctic loon	0	0
Red-throated loon	0	0
Common loon	0	0.03

continued.

TABLE 3.4-7 (Continued). NUMBER OF BREEDING INDIVIDUALS OBSERVED DURING MAY ALONG SURVEY SEGMENTS 52 AND 53 FROM 1957 TO 1992

SPECIES	YEARLY AVERAGE [1] (Segment 52)	YEARLY AVERAGE [1] (Segment 53)
Bald eagle	0.03	0
Bald eagle nest	0	0
Osprey	0	0
Sandhill crane	0.25	0.14
Grebe	0.03	0.03
Ptarmigan[2]	0.11	0.11
Total Ducks Observed[3]	29.23	24.47

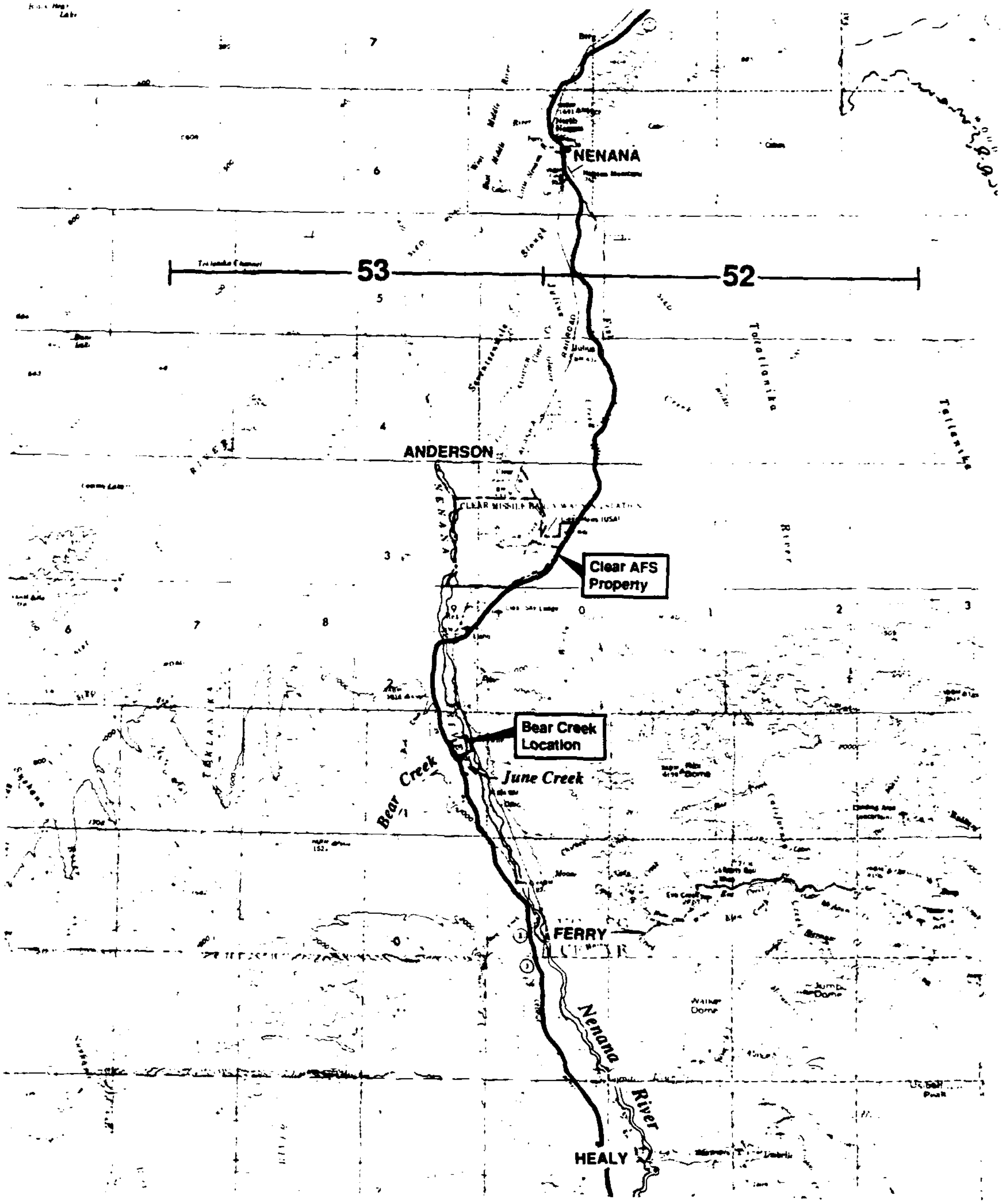
Source: USFWS, 1992f.

[1] Breeding individuals averaged over 35 years from 1957 until 1992. The following criteria was used for counting breeding individuals:

- each individual of a pair
- lone hens were not counted
- drakes were multiplied by 2

[2] All observed scaups, ring-necked ducks, swans, geese and ptarmigan were counted as breeding individuals.

[3] Total Ducks = total breeding ducks counted according to the above given criteria.



SOURCE: USGS Fairbanks, Alaska 1977

NOTES: Segments 52 and 53 are each 16 by 1/4 miles in area. Aerial survey data of breeding waterfowl have been collected every year during late May since 1957.

FIG. 3.4-5. AERIAL SURVEY SEGMENTS 52 AND 53

The nesting areas of the American peregrine falcon and the arctic peregrine falcon are, respectively, the forested areas of interior Alaska and the tundra areas of northern and western Alaska (USFWS, 1992d). Although the American peregrine falcon nests in the forested areas of interior Alaska, it is unlikely that they nest on the Clear site (ABR, 1992). There are no known nests sites within 10 miles of the Clear site (Clear AFS property or Bear Creek location) (USFWS, 1992e).

The breeding population of American peregrine falcons in interior Alaska has generally been increasing over the past 10 years. The arctic peregrine falcon population has also been steadily increasing over the past 10 years, and this subspecies was recently reclassified from endangered to threatened (M&E/H&N, 1989a).

3.5 AQUATICS

3.5.1 Gakona Site

No aquatic resources are located within the Gakona site (M&E/H&N, 1989b). However, potential borrow sources (Figure 2.3-4) identified for possible use during construction of the facility are in close proximity to the Copper River. One of the potential sources, P-1, is also near Tulsona Creek. Therefore, existing aquatic resources for these two aquatic systems are described in this section.

Copper River. Biological productivity in the Copper River Basin appears to be highest within clearwater streams and the numerous surface lakes which feed into the Copper River (M&E/H&N, 1989b). The river itself is characterized by seasonally-elevated levels of suspended sediments (Emery et al., 1985), with glacial melting from May through August yielding the highest sediment loads. Although chemical water quality is good (Section 3.6), the high suspended sediment levels and associated turbidity limit biological productivity. Floating and attached plant forms are limited due to ice scouring effects and because of reduced light levels which inhibit photosynthesis. Bottom-dwelling animals do not proliferate because siltation tends to smother aquatic insects and other forms that live in the river bottom.

While biological productivity within the river may be limited, the river serves as the major migratory route for anadromous fish species (fish which spend most of their life in the sea, but migrate into freshwater to spawn). Sockeye salmon is the most abundant anadromous species in the basin, followed by coho salmon, chinook salmon and steelhead trout. Migrations upriver generally occur during warmer months. For example, chinook salmon migrate past Gakona during early June through mid-August, while sockeyes enter fresh water from late May through July. Coho salmon depart from this general trend in that they are found in fresh water from mid-August until late January (USAF, 1987).

The Upper Copper River (upstream of the Gakona River) provides habitat for two anadromous fish species, sockeye and chinook salmon. There are at least 11 drainages that serve as anadromous salmon spawning areas (M&E/H&N, 1989b). The major spawning areas are found in the Slana and Tanada drainages, although sizable numbers also utilize other lakes, sloughs, springs, and clearwater creeks throughout the drainage. After one or three years of residence, juveniles migrate out of the system after spring break-up.

Chinook salmon are found in several clearwater creeks throughout the Upper Copper River. The most extensively used area for spawning is the East Fork of the Chistochina River (M&E/H&N, 1989a). Chinook fry in the Copper River drainage normally spend one year in freshwater before migrating to sea. They can be found in almost any clearwater tributary during the summer.

The Upper Copper River also provides habitat for several resident fresh water fish species. These include arctic grayling, burbot, and lake trout (USAF, 1987). Other species known to occur include Dolly Varden char, round whitefish, longnose sucker, slimy sculpin, and Pacific lamprey (M&E/H&N, 1989b). Species such as grayling, whitefish, longnose sucker, burbot, and sculpin may use certain areas of the mainstem Copper River for overwintering and as a migratory corridor in the spring and fall to access spawning or rearing habitat (clearwater lakes and streams).

Tulsona Creek. Tulsona Creek is a meandering riffle/pool stream originating in the muskeg and spruce vegetated hills west of the Copper River and east of the Gakona River. It has a drainage basin of approximately 91 square miles. The moisture-retaining qualities of the vegetated ground cover in the drainage basin apparently control seepage into the stream from snowmelt, resulting in a relatively constant flow of water through the stream channel during the summer months. Generally during the spring, rapid snowmelt results in a higher discharge. Winter flows appear to be quite low, with portions of the stream bed dewatered (AEIDC, 1989a).

Monthly aquatic surveys were conducted in Tulsona Creek from May through October, 1988, to develop baseline conditions for the environmental assessment of impacts associated with the OTH-B program (AEIDC, 1988d). These studies indicated that Tulsona Creek is a moderately productive stream providing rearing and possibly spawning habitat for both resident and anadromous fish species. Substrates were found to be varied, but generally consisted of medium gravel to cobble with occasional boulders in some stream segments. Sandy mud deposits were noted throughout the creek reach, but gravel substrates were continuous within the channel thalweg area (area of channel which remains flowing during low flow conditions). At the mouth of the creek where the gradient and velocities were low, extensive sand and mud deposits existed along the banks. Substrates considered suitable for salmonid spawning were documented in various segments of lower Tulsona Creek.

The 1988 AEIDC studies reported that aquatic vegetation in Tulsona Creek was dominated by a filamentous chlorophyte growing on gravel and cobbles (AEIDC, 1988d). This algal growth was found to be common along the course of the creek, but by late summer and fall algal growth declined. Periphyton were also reported to be present on many exposed surfaces.

The benthic community in Tulsona Creek was characterized during the 1988 surveys to be of moderate abundance but low diversity (AEIDC, 1988d). Species densities from pooled samples ranged from 46 organisms/square foot in May to 184 organisms/square foot in October. A total of 12 orders/families were identified. Caddisfly and chironomid larvae were relatively abundant throughout the study period as were mayfly nymphs. Chironomid and simulid larvae were also abundant during the October survey.

Slimy sculpin, arctic grayling and chinook salmon were the most common fish species upstream of the mouth during the 1988 surveys (AEIDC, 1988d). Other species collected included long-nosed sucker and Pacific lamprey. Tulsona Creek is considered within the range for char, burbot, and possibly steelhead trout (USAF, 1987). No direct evidence of spawning was noted during the 1988 surveys, but observations of very small (young-of-the-year) round whitefish, sculpin and arctic grayling indicated that they may spawn in the area. Several adult chinook

salmon were observed milling and porpoising in the mouth of the creek during the June survey, possibly indicative of spawning. Juvenile chinook salmon were collected from June through October at all study sites, including the mouth.

Gravel Source Areas. Gravel source P-1 is located at the confluence of lower Tulsona Creek and the Copper River (Figure 2.3-4). This site is closely associated with aquatic resources from both waterbodies. Three gravel pit lakes associated with the area occur near the mouth of Tulsona Creek. The 1988 surveys of Tulsona Creek included limited sampling of the large and small lakes (AEIDC, 1988d). The lakes do not appear to have year round inlet or outlet streams. The small gravel pit lake connects to Tulsona Creek through a small outlet stream which in the 1988 survey flowed from May to August. No fish were collected from the small gravel pit lake during the 1988 surveys. Burbot and longnose sucker were found in the large gravel pit lake.

The remaining potential material sources are close to the Copper River and thus exhibit similar aquatic environments. Area P-2 is located just west of area P-1. Two small intermittent streams cross this site. Because of the size of these streams and their intermittent nature, it is unlikely that they support significant benthic or fish populations. Site A-1 consists of an upper flat-topped terrace and a lower terrace separated by a small drainage swale. A pond approximately 500,000 square feet in area is located on the upper terrace area of the site. Although no aquatic resources are located within areas A-4 and A-5 (M&E/H&N, 1989b), both sites are located adjacent to the Copper River. The western portion of site A-5 contains overflow channels from the Copper River which may be temporarily used by aquatic species during high-water periods.

3.5.2 Clear Site

No aquatic resources are located on the proposed Clear site. However, the aquatic resources of the Nenana River and some of its tributaries, Lake Sansing and scattered ponds will be discussed due to their proximity to the proposed facility footprints on the Clear site. Bear Creek (Figure 2.3-6) will also be discussed because it passes through the southern portion of the Bear

Creek location. No quantitative analyses of fish populations in the Nenana River Basin are known to exist (ADFG, 1992e).

Nenana River. The Nenana River is a glacial-fed, silty, turbid river. The river and its tributaries serve as a migratory route and spawning area for some anadromous fish species and provide a habitat for a number of resident nonanadromous fish species as well (ADFG, 1992e). The proposed project sites are not close to the Nenana River and, therefore, it would not be affected.

Lake Sansing. Lake Sansing, a man-made lake, is located in a rectangular pit that was probably created as a result of excavations for gravel during the construction of the base. The lake is a groundwater infiltration area for powerplant and radar operations cooling waters. Lake waters are supplemented with groundwater when needed. The groundwater is pumped on demand from 4 wells located at the fish hatchery (ADFG, 1992f). A fish hatchery was started in Lake Sansing when rainbow trout were introduced in 1972 and 1973 (ADFG, 1992f). The rainbow trout are now self sustaining (maintenance of population by natural reproduction). Rainbow trout make up 60 to 75 percent of the fish in Lake Sansing. Arctic char make up most of the remaining 40 to 25 percent of the fish along with a few arctic grayling (ADFG, 1992f). The arctic char are not self sustaining and are stocked each year during the fall and spring. Arctic grayling are also not self sustaining and have not been stocked in a number of years. Subsequently, only a few arctic grayling exist in Lake Sansing (ADFG, 1992f).

Small Man-made Ponds. A number of small man-made ponds, located within the Clear AFS property and near the proposed location for the IRI, formed in abandoned gravel pits. Some of these ponds have been stocked with arctic grayling and sheefish (ADFG, 1992f).

Bear Creek. Bear Creek is a small stream which becomes choked with ice during the winter. It reportedly does not thaw until June or July (ADFG, 1992e,f). Although limited numbers of arctic grayling probably inhabit the stream, it supports no significant sport fisheries (ADFG,

1992e,f). June Creek, located just south of the Bear Creek location was stocked with surplus coho salmon until 1988 (ADFG, 1992f), and therefore, probably provides some sport fishing.

3.6 HYDROLOGY AND WATER QUALITY

This section describes the existing hydrologic environment in the vicinity of the candidate sites for the HAARP transmitter facility and, in the case of Gakona, at potential gravel source areas. The section includes a discussion of morphology, hydrology, and water quality. Primary sources of data for the evaluation of existing conditions include existing documents, topographic and vegetation mapping, aerial photographs, and, in the case of Gakona, technical studies which supported the OTH-B Environmental Assessment (M&E/H&N, 1989b).

3.6.1 Gakona Site

Morphology. The Copper River Lowland is a relatively smooth plain between 1000 and 3000 feet above mean sea level. The candidate site is at an altitude of approximately 1900 feet above mean sea level and is fairly flat. The area is characterized as rolling terrain with morainal and stagnant ice topography (Emery et al., 1985). The valleys of the nearby Copper River and its tributaries have steep walls up to 500 feet in height (USACOE, 1987a). The nearby section of the Copper River occupies a broad flood plain, and in several areas the flow is directed into one or more smaller branches which are reunited a short distance downriver. Tulsona Creek, located to the east of the site, originates in muskeg and spruce vegetated hills and flows south to the Copper River. The confluence is located approximately two miles east of the site. At the mouth, where the gradient and water velocities are low, mud and sand deposits are extensive (AEIDC, 1988d).

Surface Water Hydrology. The site generally receives about 15 inches of precipitation annually, most of which is snow. At the site location, about five inches of the 15 inches of annual precipitation runs off as stream flow (McDonald, 1988). Stream discharges in the region are typically low from September through March, and near zero in late winter. Approximately 75 percent of the annual runoff occurs during the open-water season with the annual maximum discharge occurring in May or June as a result of snowmelt (Emery et al., 1985; McDonald, 1988).

The site is relatively well drained by poorly defined drainage pathways. The area does not contain lakes, large wetland areas, or defined streams. Individual drainage areas are probably less than one square mile (McDonald, 1988). Site runoff flows southeast toward the Copper River, and is intercepted by the Tok Cut-Off. Culverts allow drainage to flow under the highway and continue down the steep gradient to the Copper River. The estimated average flow for the Copper River at the project site is approximately 5,800 cubic feet per second (cfs). There is no potential for flooding at the site from the Copper River.

Tulsona Creek, located east of the site, has an estimated drainage area of 92 square miles. Emery et al. (1985) estimated the average discharge for Tulsona Creek to be 60 cfs, however, discharges as low as 38 cfs on 30 March and 28 July, 1982 were observed. Seepage is probably controlled by the moisture-retaining vegetation in the drainage basin which provides a relatively constant flow during summer months (AEIDC, 1988d).

There is no potential for flooding at the site from Tulsona Creek (M&E/H&N, 1989b). There is evidence of occasional flooding in the lower Tulsona Creek basin, south of the Tok Cut-Off. Evidence includes fine sediments deposited in the forests adjacent to the stream from apparent recurrent flooding, and woody debris deposited by high water found lodged in low tree branches some distance from the river edge throughout the lower mainstream. High water may create seasonal ponds in low depressions near the stream. These ponds remain filled with water throughout the summer and gradually dry out by fall.

Three gravel pit lakes occur in the vicinity of lower Tulsona Creek and are associated with gravel source area P-1. These lakes were created by past gravel mining activity. The lakes intercept the groundwater table and do not appear to have year round inlet or outlet streams. Overflow into Tulsona Creek occurs primarily from May through August (AEIDC, 1988d). A 500,000 square-foot pond abuts the northwest portion of gravel area A-1, and drains into the Copper River through a drainage channel which crosses the potential borrow site.

Groundwater Hydrology. Low permeability, as well as prevalent permafrost, restricts the water transmitting properties of the lacustrine deposits in the region, resulting in low yield aquifers. It is expected however, that viable aquifers may be located in the floodplain deposits and underlying gravel of streams near the proposed site, such as Tulsona Creek and the Copper River (McDonald, 1988).

No known springs are located on the site. A spring was located in a slough of Tulsona Creek, west of the abandoned borrow pit in the Copper River terrace. A number of 10 to 40 foot wells have been developed in the area, which derive good quality water from unconsolidated deposits above the permafrost or unfrozen terrace deposits at a maximum rate of 20 gallons per minute (Emery et al., 1985). A 400 foot deep well drilled on the Gakona site yielded about 400 gallons per minute of very poor quality water. Wells in the relatively impermeable frozen lake bed sediments usually do not yield water supplies sufficient for any purpose.

Surface Water Quality. There is little development within the Copper River Basin, thus no anthropogenic influences are known which significantly affect water quality. United States Geological Survey (USGS) water quality data indicate the streams of the Copper River Basin are of good to excellent chemical quality. Based on USGS water quality data, the only properties that exceed the recommended EPA limits for drinking water are color, iron, and manganese (Emery et al., 1985). Many streams and rivers, particularly those that are glacially fed, are subject to seasonal increases in suspended sediment.

Water quality in the surface water features of the gravel source areas is considered to be of similar quality as other surface waters. However, summer-time evaporation can increase the concentration of dissolved solids (AEIDC, 1988d).

Groundwater Quality. Groundwater quality in the Copper River Basin Lowlands is generally poor as compared to EPA recommended limits for drinking water, and usually decreases with increasing depth. Groundwater is characterized by high concentrations of dissolved solids, sodium, chloride, iron, and manganese (Emery et al., 1985). Shallow wells (10 to 40 feet) that

take water from above or within the permafrost provide a good quality water source at rates up to 20 gallons per minute. The majority of deep wells which penetrate the permafrost yield water that is unacceptable for human consumption (McDonald, 1988). The water obtained from the 400 foot deep well drilled on the site was of such poor quality, it was deemed completely unusable for most domestic purposes.

3.6.2 Clear Site

Morphology. The Clear region is located on the margin between the Alaska Range and the Tanana-Kuskokwim Lowlands which is a relatively level plain ranging from 300 to 700 feet above mean sea level. The Clear site is located at an elevation of about 600 feet above mean sea level, with the Bear Creek location about 800 feet above mean sea level. The area around the Clear Region is characterized as relatively flat sloping terrain, although the northern foothills to the Alaska Range start abruptly only 10 miles to the south. The Bear Creek location is within the foothills region. The Nenana River flows rather rapidly out of the Alaska range and through the foothills with frequent whitewater sections and deep cuts into the surrounding terrain resulting in some river banks that are several hundred feet in height. The river gradient, and thus the velocity of the river, decreases just south (up-river) of Clear AFS, and from here to its confluence with the Tanana River it is characterized by broad slow water and braided channels, flowing over glacio-fluvial gravels (FSI, 1991).

Surface Water Hydrology. The site generally receives between 11 and 13 inches of precipitation annually, most of which is snow. Stream and river discharges in the region are characterized by very low winter flow rates, with May being the period of ice break-up with flow increasing dramatically over the month and peaking in early June. The flow then dwindles off throughout the summer and fall, and settles into the low winter flow rate by early November. The Nenana River has an average peak flow rate of 10,000 cfs, and occurs sometime during the month of June. The average minimum flow rate is about 500 cfs, occurring during the month of March (NOAA, 1982).

The 100 year flood plain for the Nenana River near Clear AFS property is well below the elevation of the proposed Clear footprint. A record high water elevation of 574 feet above mean sea level was recorded at Clear AFS as a result of an ice-jam on Julius Creek during spring break-up (FSI, 1991). There is no potential for flooding at the Bear Creek location as the site is well above the 100 year flood plain.

The site area is well drained as a result of the sandy and gravelly alluvial soil deposits. Drainage into the Nenana River is via small open tributaries, particularly where the river flows out of the Alaska Range through the northern foothills. In the flat portion of the basin, there are relatively few tributary streams, since the surface water tends to flow down through the granular soils and into the aquifer.

The Clear AFS property contains no natural streams, ponds or lakes, and is only occasionally marshy in small surface area deposits of sandy silt. There are two man-made powerplant ponds on site; oneof which is a fish hatchery pond referred to as Lake Sansing.

The Bear Creek location is bordered to the south by Bear Creek and June Creek, and to the east by the Nenana River. The flow in the two creeks is seasonal in nature with no flow during the winter period (ADFG, 1992e,f). Other than these two creeks, there is no known permanent surface water at the Bear Creek location. Inspection of stereoscopic aerial photographs verifies the presence of some marshy areas that are classified as wetland areas (NASA, 1980; Alaska Railroad, 1989).

Groundwater Hydrology. Aquifers in the Clear region are typically high-yield due to the high permeability of the underlying granular soil deposits. The water for the existing Clear AFS is obtained via 15 deep wells with yields of up to 1200 gallons per minute (FSI, 1991). The water table at the site is about 70 feet below the surface (Shannon and Wilson, 1958). There are no known springs at the site.

Water at the Clear AFS is of very good quality with only a limited amount of softening required prior to human use and consumption (FSI, 1991). Chlorine disinfection is also conducted as a precautionary measure to destroy viruses, protozoans, and bacteria picked up within the distribution system (FSI, 1991).

Surface Water Quality. The Nenana River Basin has limited development by contiguous U.S. standards, although by Alaskan standards it has a rather moderate amount of development. Communities and developments in the area includes the Denali Park entrance complex and the communities of Healy and Ferry upstream of the proposed Clear site, and the communities of Clear, Anderson, and Nenana located downstream. In addition to these major areas, there are several other small settlements and homesteads along the banks of the Nenana River that could contribute to water quality degradation in the area.

It is anticipated that the Nenana River would exceed recommended EPA limits for drinking water in several subject areas, including color, and possibly several other chemical constituents. Because the Nenana River is glacially fed and the flow rates change dramatically, it is subject to seasonal variations in suspended sediments.

Information on the water quality of the tributary streams (i.e. Bear Creek and June Creek) to the Nenana River are not available. Because they are fed primarily by snowmelt from the foothills of the Alaska Range, it is anticipated that these waters would be of excellent quality.

Groundwater Quality. Groundwater quality in the region is generally good, with minimal treatment required to make it potable. Clear AFS uses deep wells to acquire the water for the station use, and treatment is limited to selected softening and chlorination procedures (FSI, 1991).

3.7 AIR QUALITY

This section describes the existing air quality for both the Gakona and Clear sites. The discussion is broken into several sections including air quality setting, climatology and meteorology, and ambient air quality.

3.7.1 Gakona Site

Due to its remote location, the ambient air quality of the Gakona region has not been extensively studied in the past, although some limited meteorological and air quality monitoring data have been collected near the Gakona site. Air quality at the Gakona site is expected to be nearly pristine, according to ADEC (USAF, 1989a).

Air Quality Setting. The topography and physiographic nature of a site can be important to the air quality characteristics. The Gakona site is located in the Copper River Basin, an intermountain lowland flanked on all sides by mountainous uplands. These lowlands are generally flat with numerous small thaw lakes which have resulted from warming and subsidence of the permafrost soil. The basin is bordered on the south by the Chugach Mountains, which contain several peaks over 10,000 feet, on the west by the Talkeetna Mountains, and on the north and east by the Alaska Range and Wrangell Mountains. The nearest population center, the village of Gakona, is located approximately 9 miles southwest of the Gakona site (population 25 (1990)). The town of Gulkana is a larger community located approximately 15 miles southwest (population 103 (1990)). The largest community in the area is Glennallen (population 451 (1990)) located about 20 miles southwest (USDOC, 1992).

Climatology and Meteorology. The Gakona site, at a maximum elevation of 1,940 feet above mean sea level, is located within a continental climate zone which is characterized by cold, dry winters and comparatively warm summers (McDonald, 1988). Mean summer temperatures at the site range from a minimum of 41 °F to a maximum of 63 °F. Mean winter temperatures range from a minimum of -12 °F to a maximum of 6 °F. Temperature extremes have been

reported as -60 °F and 91 °F (USAF, 1986b). More detailed climate data have been recorded at Gakona townsite, elevation 1,460 feet above MSL, and show very similar values to those from Gulkana (Table 3.7-1). The average freeze-free period is approximately 114 days in the Copper River Basin (USAF, 1986b).

Mean annual precipitation at the Gakona site and at Gakona townsite has been reported at 10.9 and 13.3 inches, respectively (McDonald, 1988). However, standard rain gauges, which were used to obtain these measurements, are inefficient for determining snow deposition, resulting in inaccurate measurements of annual levels of total precipitation. Mean annual measurements of regional snowfall are best represented by data from the Soil Conservation Service Snow Course, located approximately 15 miles south of the Gakona site, on the Sanford River, at an elevation of 2,280 feet above MSL (Table 3.7-2). When converted to water equivalent, these snow data, in combination with on-site data for annual rainfall, yield an annual precipitation estimate of approximately 15 inches (McDonald, 1988). Maximum snow accumulation in nearby Gulkana is 55 inches. July and August tend to be the wettest months, while April tends to be the driest (USAF, 1986b; Table 3.7-1). The average relative humidity is reported to be 79 percent in the winter and 64 percent in the summer (USAF, 1987).

Prevailing winds in eastern interior Alaska, including the Gakona site, are relatively gentle, generally ranging between 5 and 13 miles per hour (mph). Winds during the summer are most frequently from a southerly direction with average speeds of 5 to 6 mph. During the winter, prevailing winds are most frequently out of the north at an average speed of 3 to 4 mph (USAF, 1987). Spring and fall are characterized by prevailing southeasterly winds with crosswinds from the northeast, particularly during the fall (AEIDC, 1988c). Winds seldom exceed 6 mph, and storm winds exceeding 20 mph are historically rare. Maximum sustained wind velocities at the town of Gulkana are 51 mph out of the east-southeast during the winter, and 34 mph out of the south-southeast during the summer (USAF, 1987).

Weather patterns are relatively consistent in the Copper River Basin. Topography within the basin results in a local uniformity in wind patterns. The mountain ranges surrounding the basin

TABLE 3.7-1. CLIMATE SUMMARY FOR GAKONA, ALASKA ELEVATION 1460 FT[1]

Month	Temperature (Degrees F)					Precipitation (in.)	
	Average High	Average Low	Mean	Record High	Record Low	Mean	Max. Day
January	3.5	-14.9	-5.7	44	-62	0.56	0.45
February	12.9	-14.2	-0.6	43	-54	0.71	0.30
March	30.5	0.2	15.4	49	-43	0.51	0.73
April	44.8	18.7	31.8	68	-19	0.41	0.60
May	58.8	30.2	44.5	78	10	0.71	0.99
June	68.1	40.5	54.3	83	27	1.64	0.65
July	72.2	44.9	58.6	89	32	2.45	0.90
August	69.0	41.0	55.0	91	20	1.92	1.05
September	56.7	31.9	44.3	77	5	1.28	1.55
October	37.2	18.6	27.9	55	-23	1.29	0.75
November	13.4	-4.2	4.6	45	-38	0.92	1.39
December	4.7	-12.5	-3.9	44	-40	0.94	0.78
Year	39.9	15.0	27.2	91	-62	13.32	1.55

Source: McDonald (1988) [1] Based on 13 years of observation through 1984

TABLE 3.7-2. SNOW SURVEY DATA SUMMARY FOR SANFORD RIVER, AK ELEVATION 2280 FT[1]

Month	Snow Fall (inches)			
	February 1	March 1	April 1	May 1
Average depth	21	24	25	11
Maximum depth	34	36	42	38
Average Water Equivalent	3.7	4.6	5.3	2.9
Maximum Water Equivalent	6.1	7.6	8.4	9.3

Source: McDonald (1988) [1] Based on 16 years of observation between 1967 and 1982

block or mitigate the severity of many of the storm systems coming from the west, southwest, and south. These conditions can also produce funneling effects through canyons and passes, producing a locally stronger wind (AEIDC, 1988c).

In the spring, local heating in the Copper River Basin produces rising air around the Gakona region. Cool air from the Wrangell Mountains to the southeast sinks and flows at surface level into the basin, causing a locally convective wind (AEIDC, 1988c). It is under these conditions that dispersion most readily occurs. In the winter, temperature inversions are common. Inversions with minimal winds produce the least favorable conditions for dispersion.

Ambient Air Quality. The State Air Quality Classification for Prevention of Significant Deterioration (PSD) for the Gakona site is Class II (USAF, 1986a). The Wrangell-St. Elias National Park, located 1.5 miles south of the Gakona site, is also a Class II area (Alaska Administrative Code, Title 18, Chapter 50). At the Gakona site, the concentrations of contaminants in the ambient air are less than state standards, and therefore, must be kept below these standards.

The Alaska Department of Environmental Conservation (ADEC) considers the ambient air quality of the region to be very pristine (USAF, 1987). Currently, the only important point source to background pollutant levels in the region is the Copper Valley Electric Association's powerplant located in Glennallen, approximately 24 miles southwest of the Gakona site. The emissions from this diesel-fueled powerplant do not exceed the standards set forth in the ADEC Air Quality Control Regulations, and therefore the plant does not require ambient air quality monitoring or a PSD permit (M&E/H&N, 1989c).

Minor air pollutant emissions from automobiles and local residents are the only other known sources of man-made air pollution in the Gakona region. ADEC has indicated that ambient air pollutant concentrations at the project site for nitrogen dioxide, sulfur dioxide, and carbon monoxide are expected to be below instrument detection levels (M&E/H&N, 1989c).

Based upon a Class II status and assumed pristine conditions, the ADEC normally suggests that ambient air quality be characterized through the use of assumed background pollutant concentrations. The assumptions for such a characterization should be based upon air quality documents from other projects, in remote regions, that were previously approved by ADEC (M&E/H&N, 1989c). The ADEC has approved the use of the assumed background values listed in Table 3.7-3 to characterize the air quality of remote regions of Alaska (M&E/H&N, 1989c). These values were used in permitting the proposed OTH-B powerplant on the Gakona site. Table 3.7-3 also lists PSD significance levels as identified in 18 AAC 50. For projects subject to PSD review, background pollutant concentrations that are less than these significance levels are not subject to preconstruction monitoring programs as part of the PSD review process. Based on the assumed ambient concentrations, existing SO_2, NO_2 and CO concentrations may be considered insignificant and will not require preconstruction monitoring.

ADEC has stated that existing concentrations of total suspended particulates (TSP) in the Gulkana region are likely to exceed the PSD significance level (10 $\mu g/m^3$) during spring and fall due to increases in glacial particulates resulting from short periods of dry weather and relatively high winds (M&E/H&N, 1989c). ADEC required monitoring of TSP and particulate matter less than 10 microns in diameter (PM_{10}) as part of the PSD review process for the proposed OTH-B powerplant on the Gakona site.

Particulate matter monitoring for TSP and PM_{10} was performed adjacent to the Alascom tower, located just outside of the site's eastern boundary. Monitoring was conducted from April 1989 through April 1990. The average value of TSP during the snow-free period (April through September) was 11.8 $\mu g/m^3$, with values occasionally exceeding 20 $\mu g/m^3$. PM_{10} levels averaged 4.5 $\mu g/m^3$ during this period and never exceeded 20 $\mu g/m^3$.

Table 3.7-3 lists the National Ambient Air Quality Standards (NAAQS) for the parameters for which standards have been established. A proposed source of air emissions is not permitted to exceed these concentrations.

TABLE 3.7-3. ASSUMED AIR QUALITY POLLUTANT CONCENTRATIONS FOR REMOTE AREAS OF ALASKA

Pollutant	Assumed Ambient Concentration ($\mu g/m^3$)	PSD Significance Level ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
SO_2, 24-hr average	2 - 3	13	365
NO_2, annual average	2 - 10	14	100
CO, 8-hr average	500	575	10000
TSP, 24-hr average	NA[1]	10	150
PM_{10}, annual average	NA	NA	50

Source: M&E/H&N (1989c).
[1] NA = Not Applicable.

3.7.2 Clear Site

Ambient air quality in the Clear region has not been thoroughly studied in the past due to the rather remote location of the site. Ambient air quality on the Clear site is expected to be very good throughout most of the year. An exception to this might be during the winter months when temperature inversions occur and tend to trap combustion gases from home heating systems and vehicles and deteriorate air quality (ADEC,1992a,b). The most applicable quantitative data on air quality in the Clear region comes from a recently conducted monitoring program carried out as part of the U.S. Department of Energy's (DOE) Healy Clean Coal Project (HCCP). Concentrations of SO_2 and NO_2 and PM_{10} were recorded for a period of 12 months at a location in Healy (approximately 20 miles from the Bear Creek location and about 30 miles from Clear AFS) and near the border of Denali National Park and Preserve (DOE, 1992). That data is summarized in Table 3.7-4. Note that all ambient values are well below the NAAQS.

TABLE 3.7-4. HCCP AMBIENT AIR QUALITY DATA - 9/90 THROUGH 8/91

Pollutant	Measured Concentration ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of Standard
SO_2, 3-hr average	45[a]	1300	4
SO_2, 24-hr average	26[a]	365	7
SO_2, annual average	5	80	6
NO_2, annual average	6	100	6
PM_{10}, 24-hr average	86[a,b]	150	57
PM_{10}, annual average	5	50	10

Source: DOE, 1992

[a] Maximum measured concentration.

[b] Extreme event (forest fire smoke). Maximum value excluding this event was 31 $\mu g/m^3$.

Clear Air Force Station currently has a coal-fired powerplant capable of generating 22.5 megawatts (3 boilers at 7.5 MW each). An emergency generation system uses a 1400 hp diesel powered generator capable of 1 MW output. This power generation system is about 30 years old and no significant upgrades have been employed. This facility currently operates at a fraction of capacity (roughly 30 %) and might be able to accommodate any increased loading required by the HAARP program. Clear AFS is currently operating within all applicable borough, state, and federal guidelines for air emissions (FSI, 1991). ADEC requires that Clear AFS operate each coal boiler at no more than 80% of capacity, so two 7.5 MW units operate at a fraction of capacity to meet the 7 MW loading (FSI, 1992b). The operating permit for the powerplant at Clear AFS includes no background monitoring data, but is limited to source testing at the stacks every five years and occasional visual inspections by the state.

Air Quality Setting. The Clear site is located in the Nenana River basin area in the physiographic province referred to as the Tanana-Kuskokwim Lowlands. The site is at the margin between this lowland region and the Alaska Range which juts up approximately 10 miles to the south.

Denali National Park and Preserve's northern border is located approximately 20 miles south of the Clear AFS property and 10 miles south of the Bear Creek location. The nearest population center to the site is the town of Anderson (population 646 (1989)) located only 2 miles north of Clear AFS. Other population clusters include Ferry (25 miles south), Healy (40 miles south), and Nenana (20 miles north).

Climatology and Meteorology. The Clear site is at an elevation of 580 feet above mean sea level. The site is in a region that is classified as a "continental" climate zone and is cut off from the maritime influence by the natural blockade of the Alaska Range to the south. Winters tend to be cold and dry while summers are warm and sunny. Mean temperatures for the month of July include a maximum, minimum, and average of 70.5 °F, 50.7 °F, and 60.6 °F, respectively. January means are 0.1 °F, -22.0 °F, and -11.6 °F for the maximum, minimum, and monthly average. The average yearly temperature is 25.2 °F (ENRI, 1992). The average freeze-free period at the Clear site is about 101 days, with the first killing frost averaging on August 30 and the last on May 21 (FSI, 1991).

Mean annual precipitation at the Clear site is 12.72 inches, with annual precipitation at the town of Healy (approximately 20 miles south) being slightly greater than 15 inches (ENRI, 1992). Table 3.7-5 contains a summary of the temperature and precipitation data for Clear AFS. Because of the large percentage of the precipitation that occurs as snowfall, the accurate determination of precipitation amount depends on accurate snow catch rates, regardless of wind conditions. It is generally accepted that standard gauges tend to under-estimate the snowfall, so the actual precipitation amount could be up to 20% more than the amounts presented above.

The mean total snowfall at the site is about 45.6 inches, with a record snow depth on the ground of 44 inches. Measurable amounts of snow occur during the months of September through May, with an average of 181 days with 1 inch oı snow or more on the ground (ENRI, 1992). See Table 3.7-6 for a summary of snowfall data.

TABLE 3.7-5. CLIMATE SUMMARY FOR CLEAR, AK ELEVATION 580 FT[1]

Month	Temperature (Degrees F)					Precipitation (in.)	
	Average High	Average Low	Mean	Record High	Record Low	Mean	Max. Day
January	0.1	-22.0	-11.6	51	-63	0.59	0.70
February	6.1	-14.9	-4.4	55	-57	0.39	0.90
March	21.3	-3.7	8.9	52	-49	0.31	1.30
April	38.7	17.1	28.0	71	-26	0.26	0.28
May	56.7	35.9	46.3	80	19	0.67	0.82
June	68.6	47.3	58.0	96	30	1.72	1.50
July	70.5	50.7	60.6	90	33	2.71	1.62
August	66.0	45.2	55.6	85	22	2.48	4.58
September	52.7	32.3	42.5	73	3	1.10	1.30
October	29.4	13.5	21.5	59	-29	0.93	0.92
November	11.4	-7.2	2.1	53	-42	0.84	0.63
December	5.0	-15.3	-5.0	49	-57	0.72	0.86
Year	35.5	14.9	25.2	96	-63	12.72	4.58

Source: ENRI (1992)
[1] Based on 22 years of observation (1965-1987).

Wind information at the Clear site is not recorded or available through University of Alaska Anchorage - Environmental and Natural Resources Institute (ENRI), National Weather Service - National Climatic Data Center (NWS-NCDC), or the USAF Environmental Technical Applications Center (ETAC). Wind data is taken at Healy, AK (about 30 miles south of Clear) for 16 hours out of the day, and at Nenana, AK (20 miles north of Clear AFS) on a continual basis. The NCDC collects the data from these sites and files it, but does not analyze or

TABLE 3.7-6. SNOW FALL DATA FOR CLEAR, AK ELEVATION 583 FT[1]

Month	Snow Fall			
	Average Total (inches)	Maximum Depth (inches)	Year	Average Days w/ more than 1 inch of snow cover
January	6.7	44.0	85	29.4
February	5.2	31.0	67	28.0
March	4.1	30.0	72	29.2
April	2.4	31.0	66	19.9
May	0.2	11.0	72	1.4
June	0.0	0.0	ND[2]	0.0
July	0.0	0.0	ND	0.0
August	0.0	0.0	ND	0.0
September	0.4	4.0	72	0.5
October	8.1	14.0	74	15.5
November	11.2	26.0	70	28.1
December	7.3	44.0	84	29.0
Year	45.6	44.0	ND	180.9

Source: ENRI (1992)

[1] Based on 22 years of record between 1965 and 1987.

[2] ND = No Data.

summarize the data. The nearest "first order stations" at which data are continuously collected and analyzed are Fairbanks and McGrath, both of which are a substantial distance away from Clear. Projecting weather data and information from these sites to the Clear site would not be appropriate.

Wind data for a one year period was recorded at two Healy locations in association with the proposed HCCP. This information was recorded at a 100-foot height above ground level. The prevailing winds are from the south-southeast, with a secondary prevalence from the northwest (DOE, 1992). These directions are roughly the orientation of the Nenana River Valley and demonstrate the funneling effect of the local mountain topography. Although Healy is near the Clear site (approximately 20 miles from Bear Creek and 30 miles from Clear AFS) it would not be appropriate to project wind information from one location to the other due to the difference in terrain. However, the data are probably indicative of wind directions at the Clear site and particularly the Bear Creek location.

As previously stated in Section 3.7.1, the winds in interior Alaska are relatively gentle. Design wind speeds for interior Alaska, as given by American National Standards Institute (ANSI, A58.1), are 70 mph, which is the lowest design wind speed allowed by the applicable building codes. Wind speeds at the Bear Creek location are expected to be higher than at Clear AFS property as a result of funneling through the Nenana River Valley and other localized mountain effects.

Ambient Air Quality. The State Air Quality Classification for Prevention of Significant Deterioration (PSD) for the Clear site is Class II (ADEC, 1992a). Denali National Park and Preserve located 20 miles sout.. of Clear AFS Property is classified as Class I (Alaska Administrative Code, Title 18, Chapter 50).

The Alaska Department of Environmental Conservation considers the ambient air quality of the region to be very good (ADEC, 1992b). The major sources of pollution in the area would be

the Clear AFS powerplant, home heating systems and motor vehicles. According to ADEC, no published information or data exists on ambient air quality in the region (ADEC, 1992b).

Table 3.7-3 and 3.7-4 lists the NAAQS for the parameters for which standards have been established. A proposed source of air emissions is not permitted to exceed these concentrations.

3.8 SOCIOECONOMICS

The following sections discuss the socioeconomic conditions which exist for the communities in the vicinity of the Gakona and Clear sites. The most comprehensive information base available for the communities surrounding the Gakona site was obtained during household surveys conducted during 1988 by the University of Alaska, Arctic Environmental Information and Data Center (AEIDC, 1988e). The surveys collected demographic and employment information from approximately 38 percent of households in the Copper River Basin. Additional information for the communities surrounding the Gakona site and almost all of the information for those surrounding the Clear site was derived from United States census data procured from the U. S. Bureau of the Census (USDOC, 1981; 1992).

A discussion of aircraft operational and airspace concerns is included in this section since the use of aircraft plays such a large role in rural Alaskan transportation and is directly related to the socioeconomics of the regions. Alaska air traffic routes, for both commercial and private aircraft, are directed by the mountainous terrain common to Alaska. The lower flying private aircraft utilize the sparse highway system as reference points for visual navigation. It is very common to see private aircraft following highways to and from their destinations. Private aircraft in Alaska are a common mode of transportation due to the size of the state and available landing sites along flat stream beds, lakes, ponds, glaciers and frozen rivers. In addition to commercial and private flights, Alaska airspace is used by the military for training missions.

3.8.1 Gakona Site

The closest communities to the site are Gakona, Glennallen, Chistochina, and Gulkana (Figure 2.3-4). The following sections discuss land ownership, population, economy, housing, community services, and aircraft operations in and around the Gakona region.

Land Ownership Issues. The HAARP facilities at the Gakona site would be located completely on Air Force property. Thus, no land purchases from state or local governments, Native groups, or private individuals will be necessary for the construction of the HAARP facilities.

Population. Most communities in the Copper River Basin consist of small villages, with populations ranging from around 13 to 500 (AEIDC, 1988e). Many of these villages experienced a moderate degree of growth during the 1970's associated with construction of the Trans-Alaska Pipeline. Census data for the period of 1970 to 1990 from the communities nearest the candidate site (Chistochina, Gakona, Glennallen and Gulkana) are presented in Table 3.8-1. The community of Glennallen is included in the table as it is one of the larger population centers in the region.

The 1990 census data indicate that since 1980 the number of residents in Chistochina and Gulkana has remained fairly stable and the numbers of residents in Glennallen and Gakona has decreased. The relative stability in population exhibited by Chistochina and Gulkana may be attributed to the high number of Alaska Native residents, who represent about 60 percent of residents in both census areas. In contrast, no Alaska Natives were in residence in Gakona, and only 7 percent of the Glennallen population were native. In the absence of a significant increase in employment opportunity, population levels are likely to continue the relatively flat trends evident in the 1990 census.

Housing. Housing information for the four communities described for population statistics is summarized in Table 3.8-2. Housing units consist mostly of single-unit detached structures and mobile homes or trailers. The highest number of multi-unit dwellings occur in Gulkana and Glennallen. Vacancies for all dwellings ranged from 21 to 42 percent, with the highest rates reported in Gakona and Chistochina. Gakona and Glennallen had the lowest proportion (20 and 12 percent, respectively) of seasonal, recreational, or occasional use dwelling vacancies compared with the other two census areas.

TABLE 3.8-1 POPULATION TRENDS FOR COMMUNITIES IN THE GAKONA REGION

U.S. CENSUS YEARS	1970	1980	1990
Chistochina	33	55	60
Gakona	88	87	25
Gulkana	53	104	103
Glennallen	363	511	451

Source: USDOC, 1992.

TABLE 3.8-2 HOUSING DATA FOR COMMUNITIES IN THE GAKONA REGION

HOUSING DATA	# UNITS	OCCUPIED	PERCENT VACANT	PERCENT SEASONAL VACANCY	PERCENT RENTAL VACANCY
Chistochina	34	20	41	36	0
Gakona	12	7	42	20	67
Gulkana	60	42	30	56	22
Glennallen	206	163	21	12	1

Source: USDOC, 1992.

For the most part, residences in these communities are owner-occupied. With the exception of Glennallen, rentals represented from 10 to 23 percent of the housing units. Approximately 50 percent of the housing in the community of Glennallen is rental property, and at the time of the census few of these units were vacant. Overall, a limited number of rental units were available throughout the area at the time of the census.

Economy. Subsistence, discussed in Section 3.10 Subsistence, represents the historic basis for survival of the Native inhabitants prior to contact with outsiders, and remains an integral part of present Native and non-Native lifestyles and economy. The introduction of a cash economy in the early 1800's associated with fur trading, and later with mining and construction, resulted in an evolution in the subsistence-based economy. The term frequently applied is a "mixed, subsistence market economy", indicative of the integral relationship which has developed between subsistence practices and disposable income.

Historically, the availability of wage employment has been sporadic and associated with such events as the gold rush at the turn of the century, mining for copper and other minerals, highway construction, and construction of the Trans-Alaska Pipeline. Comprehensive information from the 1988 survey is indicative of current employment opportunities, and is summarized in Table 3.8-3.

The surveys indicated that wage employment in the communities adjacent to the candidate site was dominated by professional, technical, managerial positions, structural occupations, sales and services. Employers include retailers, services, and local, state, and federal government agencies. About 67 percent of Gulkana residents who responded to the survey worked for the Ahtna/Copper River Native Association, the regional Native corporation. Average annual incomes for respondents who divulged salary information ranged from $18,200 for Gulkana residents to $35,400 for Glennallen residents. Glennallen had the highest percentage of full-time employment among employed adults (76 percent), which may be responsible for the higher average annual income. Glennallen adults were employed an average of 10.8 months per year,

TABLE 3.8-3. EMPLOYMENT DATA FOR COMMUNITIES IN THE GAKONA REGION

Community	Percent Employed Adults	Percent Full Time	Average Income	Occupational Hierarchy (1)
Chistochina	80	35	$23,600	1,6,3&5,7,2,4
Gakona	82	59	$28,100	1,6,3,2,5,7,4
Gulkana	60	44	$18,158	3,1,2&6,7
Glennallen	77	76	$35,000	1,2,7,3,6,4

Source: AEIDC, 1988e.

(1) Codes listed in order of decreasing frequency.

Codes: 1 - Professional, Technical, Managerial
2 - Clerical and Sales
3 - Services
4 - Agriculture, Fisheries, Forestry
5 - Machine trades
6 - Structural trades
7 - Other (Armed Forces, Recreation, Transportation, Mining, Arts & Crafts)

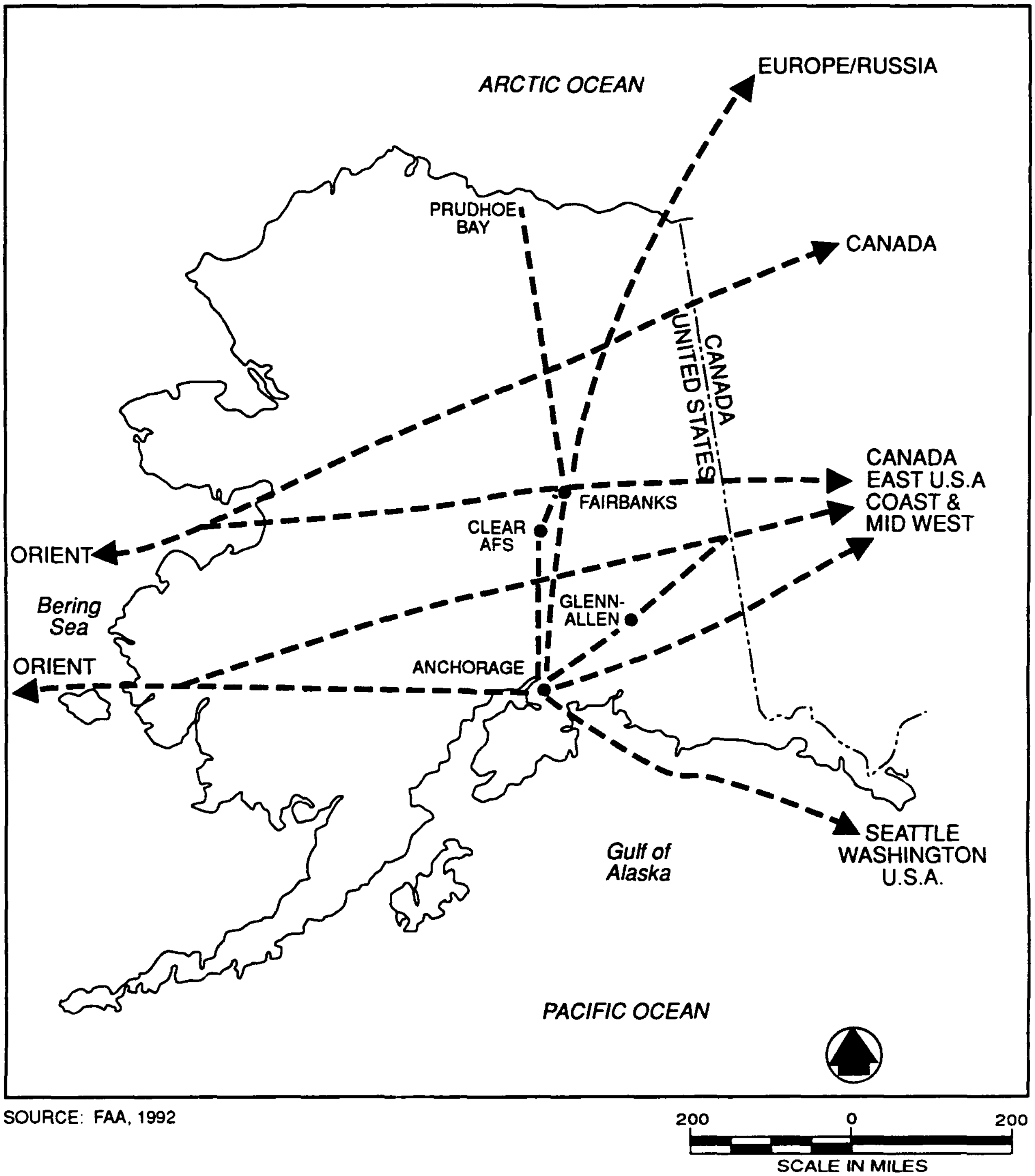
as compared with 7.6 and 7.8 months per year for Gulkana and Chistochina adults, respectively. Many adults not engaged in year-round employment are engaged in seasonal endeavors such as tourism and guide services.

Community Services. The nearest organized firefighting capability to the Gakona site is at Glennallen, about 25 miles to the south. The town has a volunteer fire department, however, their response area does not include Gakona and the HAARP project site (M&E/H&N, 1992c). ADNR has seasonal firefighting capability, but only to protect woodlands and not to respond to structure fires. Ambulance and emergency medical services are available to the Gakona area. Emergency response time to the site is estimated at 6 to 10 minutes. Emergency medical response service is considered sufficient (M&E/H&N, 1992c).

Aircraft Operational and Airspace Concerns. The Gakona Site is within a major commercial air traffic corridor that links Anchorage with the eastern and mid-western United States. It also is within the path of flights to and from the Orient and Canada (Figure 3.8-1). Twelve to twenty commercial flights per day utilize the airspace above the Gakona Site (FAA,1992). Typically, there are more flights during the summer tourist season.

Private aircraft can originate from, and travel in, almost any direction at the site since Alaskan private pilots utilize lakes, ponds, gravel bars, air strips and generally anything flat for runways. Since the site is adjacent to a major roadway, pilots use the airspace above the site as a flight corridor. Also, summer flights of private aircraft from the lower-48 United States to Alaska utilize the airspace as they fly around the Wrangell-St. Elias Mountains on their way to Anchorage. The nearest airport is at Gulkana approximately 20 miles to the south-west of the site. It is classified as a civil airport open to the general public. The airport has high intensity approach lights and asphalt runways. The longest runway is approximately 2000 feet. There is also a ski strip which is maintained in the winter.

In addition to commercial and private aircraft, military aircraft utilize the airspace north and east of the site for training (FAA, 1992). Cope Thunder and other major military aircraft operations are conducted in the area several times each year. These exercises increase air traffic in the vicinity. Military operations areas (MOA's) and temporary military operations areas (TMOA's) are designated in the area to warn non-military pilots of heavier than normal aircraft activity and unusual flight operations in the areas north of Glennallen to beyond Fairbanks and from approximately Clear AFS east to Tok. During these military exercises instrument flights are condensed and rerouted around or through the training airspace to avoid conflict. The need to keep Gakona airspace open becomes important during those exercises. The MOA's and TMOA's have less effect on private aircraft flying under visual flight rules, since they simply



SOURCE: FAA, 1992

FIGURE 3.8-1. MAJOR COMMERCIAL AIR TRAFFIC ROUTES

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warn pilots of the heavier than normal air traffic in the region at that time. Military air traffic is anticipated to increase in the coming years as Cope Thunder's mission expands.

3.8.2 Clear Site

The closest communities to the Clear site are Anderson, Ferry, Healy, and Nenana (Figure 3.4-5). The 1990 populations of the towns range from a low of 56 at Ferry to a high of 628 at Anderson (Table 3.8-4) (USDOC, 1992). The economies and the availability of accommodations vary substantially between the four surrounding communities and will be discussed in the following subsections.

TABLE 3.8-4 POPULATION TRENDS FOR COMMUNITIES IN THE CLEAR REGION

U.S. CENSUS YEARS	1970	1980	1990
Anderson	362	517	628
Ferry	< 25 *	< 25 *	56
Healy	79	334	487
Nenana	362	470	393

Source: USDOC, 1981; 1992.

* Was not recognized as an unincorporated population center (community), census designated place, with at least 25 people (ADL, 1992)

Land Ownership Issues. The HAARP facilities at the Clear site would be located primarily on Air Force property, but due to operational conflicts between the HAARP ISR and the existing BMEWS system, the ISR would be be located approximately 10 miles away at the Bear Creek location. The Bear Creek location site was selected based on operational concerns only, and is on land that is currently owned by the state of Alaska, but is planned for settlement as part of the Tanana Basin Area Plan (ADNR, 1991a). In fact, in the one square mile section that

surrounds the Bear Creek location, there are currently nine homesteaders (Figure 3.1-1) (ADNR, 1992b).

Homesteading in Alaska and acquiring of land through the homesteading process can be achieved in one of three ways (ADNR, 1992b). The first method is called "proving up", where the homesteader must meet the following three requirements:

- Have the land surveyed within two years from date of filing
- Construct at minimum a 500 square feet dwelling on the land within 3 years
- Live for 24 months (not necessarily consecutive) on the property by the end of five years

The other two methods of acquiring the land involve a purchase of the land for fair market value. This action is typically taken if one of the above mentioned requirements is not met by the milestone dates.

The nine separate homesteaders in the Bear Creek area are in various stages of meeting their proving up requirements. At the time of this writing, there is only one known dwelling in the one square mile section around the Bear Creek location. Several pieces of property appear to be at various stages in the surveying process. Additional homesteading activities could commence at any time.

Economy. The economy of Healy is based primarily on coal mining and secondarily on railroad operations, electrical power generation and tourism (Table 3.8-5) (Stalter and Shreve, 1992; Schutt, 1992). The largest employer of residents (approximately 33 percent) in Healy is the Usibelli Coal Mine (Stalter and Shreve, 1992; Schutt, 1992). The coal mine is located less than 3 miles across the Nenana River from Healy (Figure 3.4-5). The Usibelli Coal Mine is Alaska's largest and only commercial coal mining operation. Coal mining began in the area in 1918 (Alaska Northwest Books, 1992). The largest coal-fired, steam, electrical generating powerplant in Alaska is located in Healy. The plant is a part of the Golden Valley Electric Association (GVEA) that provides electric power for Fairbanks and vicinity (Alaska Northwest

Books, 1992). The proposed Healy Clean Coal Project represents an expansion of coal-fired power generation in the area. Additional employment would result from the construction and operation of this facility. Tourism makes up a portion of Healy's economy by providing a number of services to tourists travelling between Fairbanks, Denali National Park and Anchorage. According to census data (USDOC, 1992) 96.1 percent of the adult labor force is employed and the per capita income ($18,160) is the second largest of the four surrounding towns (Table 3.8-5).

The economy of Ferry is totally based on outside industries. Most of the residents work for the National Park Service at Denali, the Usibelli Coal Mine or the GVEA powerplant in Healy. The town was originally a railroad stop. However, the trains no longer stop in the summer and will only stop in the winter if flagged down (Valcq, 1992). According to the employment data the per capita income is $14,112 and 60.1 percent of the adult labor force is employed (Table 3.8-5).

The economy of Anderson is based primarily on the Clear AFS located approximately 6 miles to the south of the town (Figure 2.3-5). The majority of the employed adult labor force (58.6 percent) are military personnel that work on Clear AFS (Table 3.8-5). The remainder of the employed population work for the local, state and federal government and private enterprises. The primary function of the station is the operation and maintenance of a system that would detect an intercontinental ballistic missile attack on North America. Of the four surrounding towns, Anderson has the highest employment rate, 96.8 percent of the adult labor force, and the highest per capita income, $18,360 (Table 3.8-5). Anderson has two bars, a fire station, one high school, and one doctor.

Education, transportation, shipping and commerce provide the basis for Nenana's economy (Stalter and Shreve, 1992; Fission and Associates, 1987). Nenana is a major shipping port within the Yukon River drainage (Stalter and Shreve, 1992). The greatest percentage of the adult employed labor force, 33.8 percent (USDOC, 1992), work in the educational services

TABLE 3.8-5. EMPLOYMENT DATA FOR COMMUNITIES IN THE CLEAR REGION

Town	Percent Employed Adult Labor Force	Percent Private [1]	Percent Govern-ment [2]	Percent Armed Forces [3]	Avg.Per Capita Income ($)	Industrial Hier-archy [4]	Economic Foundation
Nenana	82.5	44.9	55.1	0	12,852	9,11,5,4, 10,3,6, 7&15,1	Transportation, Shipping, and Commerce
Anderson	94.9	17.5	23.9	58.6	18,360	13,11,9,12 3,5,6,1,10 7&8&14, 15	Clear Air Force Station, Federal Government
Ferry	60.1	57.1	42.8	0	14,112	11,2, 12&9&10, 5	Coal Mining, Power Plant, Denali National Park
Healy	96.1	71.6	28.4	0	18,160	2,9,5,12,3, 4,11,7,10, 1,6&8	Coal Mining, Power Plant, Tourism

Source USDOC, 1992

[1] percent of employed adult labor force that works for wage and salary paying private companies and that is self employed.
[2] percent of employed adult labor force that works for local, state, and federal government.
[3] percent of employed adult labor force that works for the armed forces.
[4] Industrial Class Codes in order of decreasing frequency.

Code

1 - Agriculture, forestry, fisheries
2 - Mining
3 - Construction
4 - Transportation
5 - Retail trade
6 - Business and repair services
7 - Personal services
8 - Health services
9 - Educational services
10- Other professional and related services
11- Public administration
12- Communications, other public utilities
13- Armed Forces
14- Entertainment
15- Finance, Insurance and Real Estate

industry (Table 3.8-5). The local, state and federal governments employ most (55.1 percent) of the employed adult labor force. Most of the employed government personnel work for the Nenana Public Schools and the Yukon-Koyukuk School District based on the community profile information (Fission & Associates, 1987) and Bureau of Census data (USDOC, 1992).

Transportation services are the mainstay of Nenana's private sector economy (Fission & Associates, 1987). The per capita income ($12,852) is the lowest of the four communities. Barge shipping services operate from May 15 to October 15 depending on weather, ice and flooding conditions. Fuel oil and gasoline, along with lesser amounts of building materials, make up most of the transported freight (Fission & Associates, 1987).

The local economy could be effected by a proposed U.S. Department of Energy's advanced combustion and air cleaning technologies demonstration project. The proposed project, referred to as the Healy Clean Coal Project (HCCP), is to build a new 50-MW coal-fired power-generating facility. The proposed and alternative HCCP sites are located near Healy. Construction is scheduled to begin in early 1993 and completed in late 1995. The average labor force of construction personnel is anticipated to be about 200 workers, with a maximum of 300 workers, during the later part of 1994 and early 1995. The majority of the temporary construction jobs are envisioned to be filled by in-migrants. A construction camp is planned to house up to 90% of the peak work force. Approximately 13 permanent jobs could result from the long-term operation of the proposed HCCP facility. The overall economic affect to the local economy from the project is identified as minor (DOE, 1992).

Housing. Housing information for the four near-by communities is summarized in Table 3.8-6. Housing units consist mostly of single-unit detached structures and mobile homes or trailers. Single unit detached structures are those with open space on all four sides and detached from any other structure. The highest number of multi-unit dwellings occur in Healy. Vacant dwellings, not including those used on a seasonal basis, for recreational, or for occasional use, ranged from 5 (15 percent) in Ferry to 45 (26 percent) in Healy. Vacant housing units used on a seasonal basis, for recreational or occasional use, ranged from 5 in Ferry to 14 in Healy.

Other than Ferry with three vacant rental units, vacant rental units ranged from 16 in Nenana to 18 in Anderson. For the most part, residences in these communities are owner-occupied. With the exception of Ferry, rented housing units represented from 16 percent in Nenana to 19 percent in Healy of the total available housing units. Only 3 percent of the total housing units in Ferry were rented at the time of the 1992 census.

TABLE 3.8-6. HOUSING DATA FOR COMMUNITIES IN THE CLEAR REGION

HOUSING DATA	UNITS (#)	OCCUPIED UNITS (#)	RENTED UNITS (percent)	VACANT UNITS (#)	VACANT UNITS ((percent)	VACANT SEASONAL UNITS (#)	VACANT RENTAL UNITS (#)
Anderson	179	135	17	44	26	10	18
Ferry	33	23	3	5	15	5	3
Healy	220	161	19	45	20	14	17
Nenana	190	140	16	38	20	12	16

Source: USDOC, 1992.

Community Services. Clear AFS has both firefighting and emergency medical response services. Their equipment includes 2 trucks, a rescue vehicle, and an ambulance. Clear AFS has mutual agreements with the near-by town of Anderson to provide back-up fire and emergency medical services. Response times to the proposed HAARP site areas by the fire and emergency medical personnel is estimated at 5 minutes. Both fire and ambulance service is considered sufficient (M&E/H&N, 1992e).

Aircraft Operational and Airspace Concerns. There is a special operational restricted area in place for the BMEWS radar. This restricted area is bounded on the east by the existing railroad tracks, and on the west by the Nenana River. The airspace above the proposed location for the IRI is outside of this restrict area.

There is a gravel airfield located about 1/2 mile northeast of the IRI site with the landing and take off path south of the air strip extending directly over the proposed IRI site. The airstrip is reportedly used on the average of several times per week throughout the year, with more use in the summer and fall. Although it is used primarily for private aircraft, infrequent "distinguished visitor" tours of Clear AFS have utilized the strip for access to the site. The airstrip is approximately 4,000 feet long and is equipped with medium intensity runway lighting and one aviation beacon. There are no approach lights or other navigational aids (ADOT, 1992). Operational information for this and other remote Alaskan airstrips is covered in the National Oceanic and Atmospheric Administration's Airport Facility Directory, Alaska Supplement. Geometric design and restrictions would be identified in the Federal Aviation Administration's Advisory Circular AC 150/5300-13, Airport Design Criteria (ADOT, 1992).

The Clear region is below one of the busiest commercial and private air routes in Alaska. Commercial flights to and from the North Slope (Deadhorse/Prudhoe Bay) and Anchorage, Europe/Russia and Anchorage, the Orient and Canada, and Fairbanks and Anchorage utilize the airspace above the Clear region (Figure 3.8-1). The rate of airspace use near Clear AFS ranges from 15 to 25 flights per day (FAA, 1992). Private use of the airspace above the Clear region also occurs as aircraft use the Parks Highway that leads between Anchorage and Fairbanks as a visual navigation aid. Most private aircraft stay east of Clear AFS to avoid the 8800-foot high ceiling of the restricted airspace over BMEWS.

Military aircraft exercises, such as Cope Thunder, take place in airspace to the east of the Clear region. During the military exercises, commercial and private air traffic may increase in the Clear region as a result of being routed away from airspace to the east.

3.9 CULTURAL RESOURCES

Cultural resources include properties with physical manifestations that are considered important to a culture, subculture, or community for scientific or sociological reasons. In the project region they consist of prehistoric, Native Athabaskan, and historic districts, structures, buildings, sites, objects, and other physical evidence of past human activity. In addition, cultural resources in interior Alaska include locations, structures, biota, objects, and natural features which are of value to Native Athabaskans for traditional, cultural, religious, or ceremonial purposes. Many such sites which have been discovered or are believed to exist as a result of ethnohistorical research are listed in the Alaska Heritage Resource Survey (AHRS). These resources include burial sites, contemporary sacred sites and areas, materials for the production of sacred objects and traditional implements, and zoological, botanical, and geological resources of ritual cultural importance, as well as the areas in which they are found.

The distribution of cultural resources within and adjacent to the candidate sites for the HAARP facilities is largely a result of the subsistence lifestyle (discussed in more detail in Section 3.10) which characterized both prehistorical as well as more recent inhabitants of the area. The pursuit of available natural resources led to seasonal occupation of sites near hunting and fishing areas, which were revisited from year to year. The following sections present a historical summary of the area surrounding the HAARP candidate sites and existing documentation of cultural resources.

The review of historical periods with which cultural resources may be associated includes prehistorical, ethnohistorical, and recent historical periods. The prehistorical era is defined as that which occurred prior to the last 200 years. The recent history of Native groups is termed ethnohistorical, while that of non-Native cultures is termed historical.

3.9.1 Gakona Site

Prehistorical Period. The earliest known cultural sites near the Copper River drainage are found to the northwest of the candidate site in the Tangle Lakes area west of Paxson, near the divide between the MacLaren, Gulkana, and Delta rivers (Figure 3.9-1). Termed the Denali Complex, these occupations were characterized by core and blade technology (West, 1975) with an apparent big game hunting focus. Radiocarbon dates indicate occupation between 10,200 and 8,200 years before the present (Dixon, 1985).

The candidate site for the HAARP transmitter facility is located in the eastern part of the Copper River Basin lowlands. During the late Pleistocene, a preglacial lake filled much of the basin. The lake drained about 9,000 years ago, but may have partially refilled during later climatic cycles (West and Workman, 1970). The lake bed in its present form was fully exposed by 5,000 years B.P. (before present). Only one site in the eastern Copper River Basin, located on the Gulkana River at Hogan Hill (Figure 3.9-1), is indicative of an early prehistoric human presence (Workman, 1977). The other recorded archeological sites in the eastern Copper River Basin are believed to be associated with the late prehistoric period from 200 to 2,000 years ago (Dixon, 1985; West, 1975; Workman, 1976; Spartz, 1985). These sites are near large lakes and major drainages. The majority of these sites are undated; dated sites range between approximately 200 and 700 years B.P.

Ethnohistorical and Historical Periods. The Ahtna, the primary Athabaskan group in the Gakona region, culture is characterized by a subsistence-related settlement pattern. The Ahtna were organized into independent bands consisting of a few nuclear families. Each band occupied a specific hunting territory that extended up a river drainage into the mountains (de Laguna, 1969). The diverse environment, rich in wild game and raw materials, provided the necessary resources for existence. Food resources were worked by their seasonality, and the Ahtna developed an annual cycle of activities that took advantage of seasonal scarcity and abundance (Cohen, 1980).

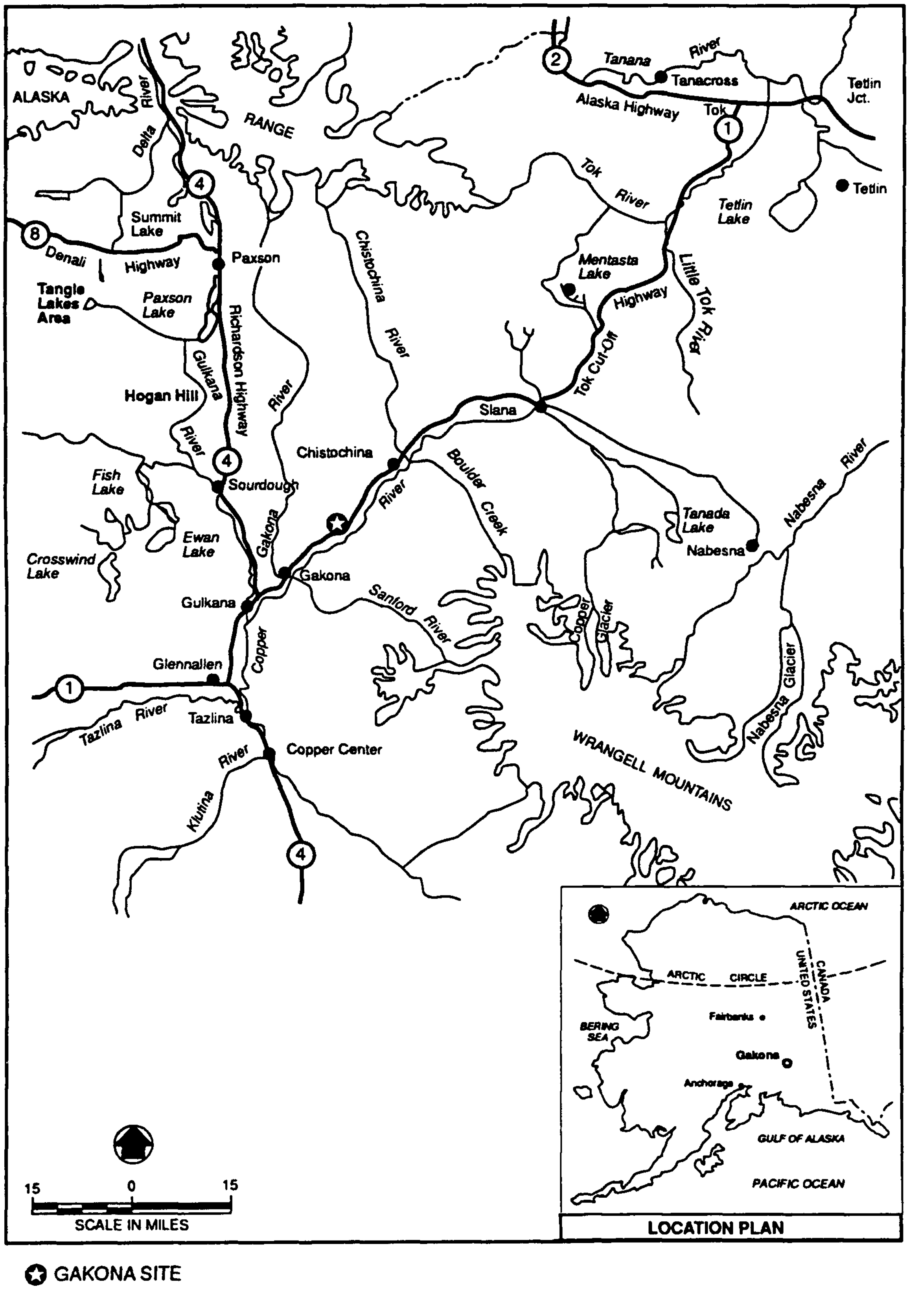


FIGURE 3.9-1. UPPER COPPER RIVER DRAINAGE AREA

Summer activities, associated with small camps along the main rivers, primarily focused on harvesting salmon and other fish. Summer fish camps were often located on favored fishing streams, many near winter villages. These sites were characterized by temporary shelters, often double-sided brush and bark lean-to, unattached sweat baths, and drying racks. Families returned to the winter villages before the first snows. Village locations were typically determined by proximity to the mouths of clear water tributary streams, by the availability of timber for construction and fuel, and by accessibility to well-drained areas for constructing food storage caches. Winter villages consisted of one to nine multifamily houses and perhaps a few huts. Ancillary facilities were located adjacent to large and small residential structures. Underground pit or tree platform food caches were located up to a mile away.

Hunting camps were usually located at higher elevations or on larger lakes and served as a base for other activities. Sometimes these camps would have small permanent structures. Less permanent camps often consisted of simple brush shelters with associated drying racks. Temporary shelter camps were also constructed at convenient locations along trails and traplines. Well-defined trails were found on both banks of major drainages and across virtually all passes. Most of these trails were later used by Euroamerican travelers (Reckord, 1983).

Prior to contact with non-Native groups the Ahtna did not have discrete cemetery sites, though their treatment of the dead could result in areas similar to such sites. Generally, because of fear of contamination and ghosts, a dying person was removed from his or her home to a small shelter if possible. If an adult died within a house, the structure was burned with all its contents. The person's body and personal possessions were cremated. The ashes might be left at the spot, but they were usually buried in a bark box. A chief's grave might be marked by wooden poles or by several stone slabs. By the mid-nineteenth century, the influence of Russian contacts had led to the introduction of burial in a plank-lined grave marked by a cross and surrounded by a fence. A little house was erected above the grave, and personal belongings were placed inside.

Post-contact with outside cultures may be divided into five periods: early Russian 1783-1806; Late Russian 1807-1867; early American, 1876-1900; twentieth century to World War II (1900-1941); and recent (1941-1975) (de Laguna and McClellan, 1981). Although early Russian contacts with Copper River people sometimes ended in violence, they established productive trading relationships that persisted until the Alaska Purchase by the United States in 1867. American explorations up the Copper River did not begin until 1884.

A number of prospectors and trappers drifted into and through the Copper River drainage during the late 1880's and early 1890's (Reckord, 1983). The gold rush of 1898-1899 brought thousands of prospectors into Ahtna territory. Two military trails were constructed through the area, along which a series of roadhouses developed and provided accommodations for travelers, dog teams, and horses. These locations became the nuclei for small settlements that achieved economic diversification through employment with government agencies such as schools, highway maintenance groups, and the United States Postal Service. Between 1910 and 1940 the two military trails were upgraded to automobile road standards, now known as the Richardson and Glenn Highways.

Before World War II, mining and transportation in the region stimulated limited economic development. World War II brought renewed activity through the construction of roads, airstrips, and communications systems. The war also brought an influx of servicemen to the area who temporarily increased the population of towns along the main roads. The postwar road connection with Anchorage provided a source of jobs for valley residents, but also created a new influx of settlers. The most recent development in the history of the region was the construction of the Trans-Alaska Pipeline in the 1970's.

Known Cultural Resources - HAARP Area. The only known site considered eligible for inclusion in the NRHP at the Gakona site is the section of the WAMCATS trail which crosses the site in the vicinity of the existing access road. The WAMCATS trail, also historically known as the Valdez-Eagle trail, is a telegraph line and trail constructed in 1901-1903 and

abandoned by the military in 1910. This trail is considered eligible for NRHP listing due to its historic significance (AEIDC, 1990).

Cultural resource surveys conducted at the site for the OTH-B program included visual and subsurface examinations of a large percentage of the estimated 1100 acre impact area identified for the OTH-B transmitter site (AEIDC, 1990), a portion of which would be occupied by the proposed HAARP facility (Figure 3.9-1). The investigations concentrated on proposed OTH-B construction areas as well as areas with a greater probability of containing cultural resources (e.g. lake shores and trails). No prehistoric or ethnohistorical period Ahtna sites were discovered during the archeological reconnaissance. A number of small trails that transect the proposed HAARP site were examined during archeological reconnaissance, most notably along the eastern boundary. These were considered to be associated with subsistence activities during the past century, and possibly contain only ephemeral hunting sites (Ahtna, 1988). The possibility of locating undetected cultural resources during construction at the OTH-B transmit site was considered unlikely, therefore no archeological monitoring was recommended at the site by the Alaska State Historic Preservation Officer (SHPO) (AEIDC, 1990). The results of these studies and the determination by the SHPO for the OTH-B project will be considered in the analysis of potential impacts associated with the proposed HAARP facility.

Known Cultural Resources - Material Source Areas. Two potential primary material source locations (P-l and P-2) were designated for the OTH-B project, and three alternative material sources (A-1, A-4, and A-5) were identified at more distant locations (Figure 2.3-4). These locations are under consideration for use as borrow sites for the HAARP project. The proximity of these sites to the Copper River and their suitability for subsistence activity suggests an increased potential for the presence of cultural resources.

Area P-1. An existing archeological site listed in the AHRS is located east of the gravel extraction area, identified in the AHRS as GUL-219. This site is a burial mound and is considered eligible for listing on the NRHP. Another site, listed by the AHRS as GUL-015 and based on ethnographic research, is believed to have been a settlement near the mouth of the

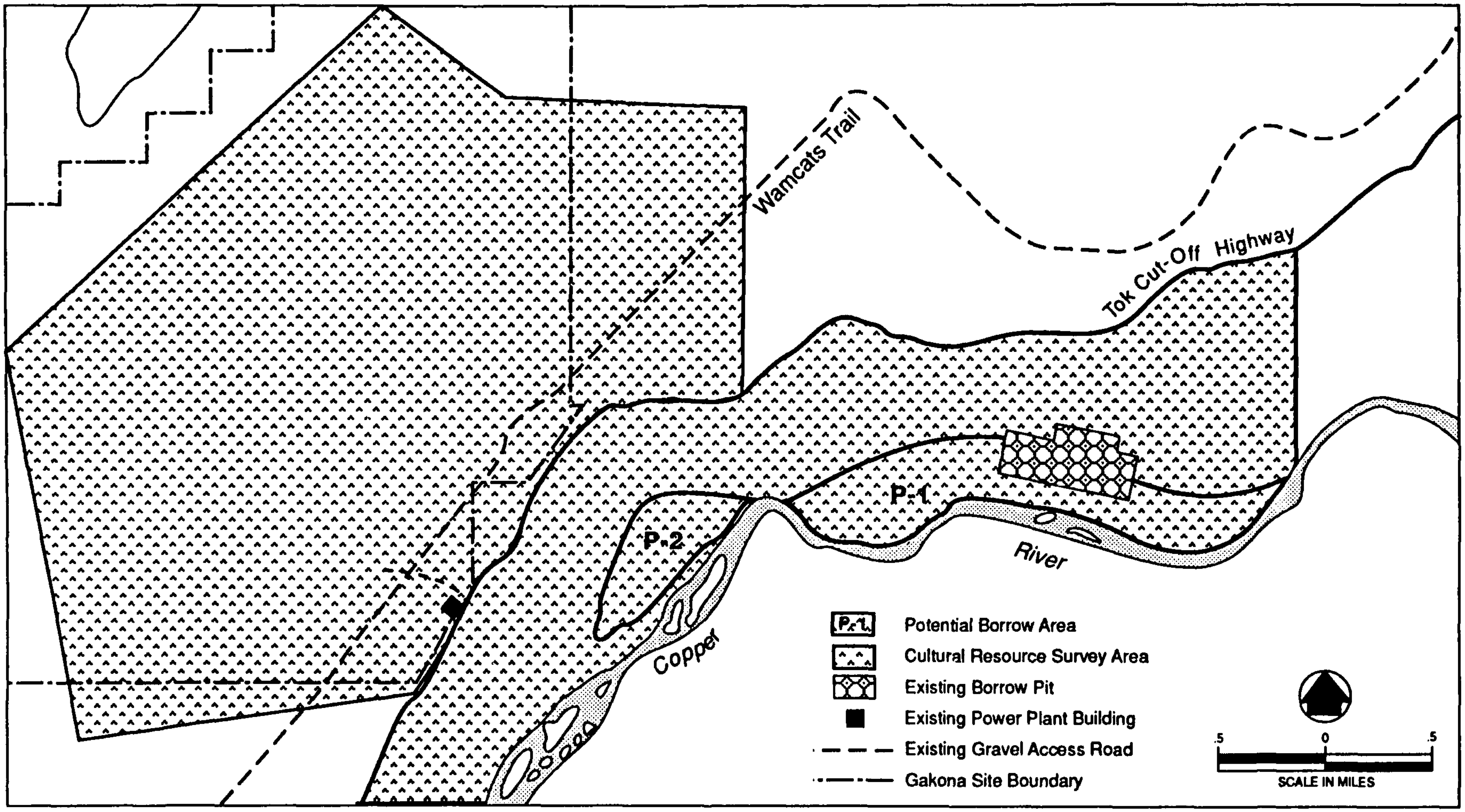
Tulsona Creek. It is possible that this site was destroyed by gravel removal for highway construction in the 1930's.

Archeological investigations were conducted at P-1 in 1990 which investigated several sites previously identified by surface reconnaissance in 1988 and 1989. The 1990 studies included subsurface investigations of the gravel site and the access corridor to the Tok Cut-off (Glenn Highway). A total of nine sites were investigated at P-1 (Figure 3.9-2), which are summarized in Table 3.9-1.

Of the documented sites, it was concluded that sites GSA-12 and GSA-14 may be eligible for NRHP listing due to their historical and cultural significance (AEIDC, 1991). GSA-12 consists of a spruce-covered landform which is a relic island in the Copper River floodplain. Evidence of Native and non-Native use of the site was found, and Ahtna elders indicated that the site was used by Chief Nicholai, who was Chief of the settlement at GUL-015. The site produced log and pit food caches and numerous artifacts despite periodic flooding of the site which may have removed many artifacts once present. GSA-14, located on the edge of the terrace above the floodplain, was a seasonal fish camp which was occupied in the early 1900's.

Area P-2. No archeological surveys were known to have been conducted at the P-2 area prior to those conducted in 1988 associated with the OTH-B project. The AHRS lists one site within this material source, an ethnohistorical settlement listed as GUL-133. A section of the protohistoric Ahtna and historical Chistochina mining trail crosses the survey area. Also, trapping trails and associated features were noted along the river terrace and following the base of the bluff.

Approximately 5 percent of P-2 was examined during the 1988 archeological survey. Subsurface investigations were conducted on slightly more than 3 percent of the area. Four sites were located during the archeological investigations. Though evidence of post-contact utilization of the sites exists, artifacts and other evidence found during archeological studies were indicative that the sites may be late-prehistoric in origin. It is considered highly likely that additional sites



Sources: U.S.G.S. Gulkana (B-3) 1977.

FIGURE 3.9-2. PROPOSED HAARP FACILITY AND POTENTIAL BORROW AREAS P-1 & P-2 CULTURAL RESOURCES SURVEY AREAS, 1988-1990

J2817

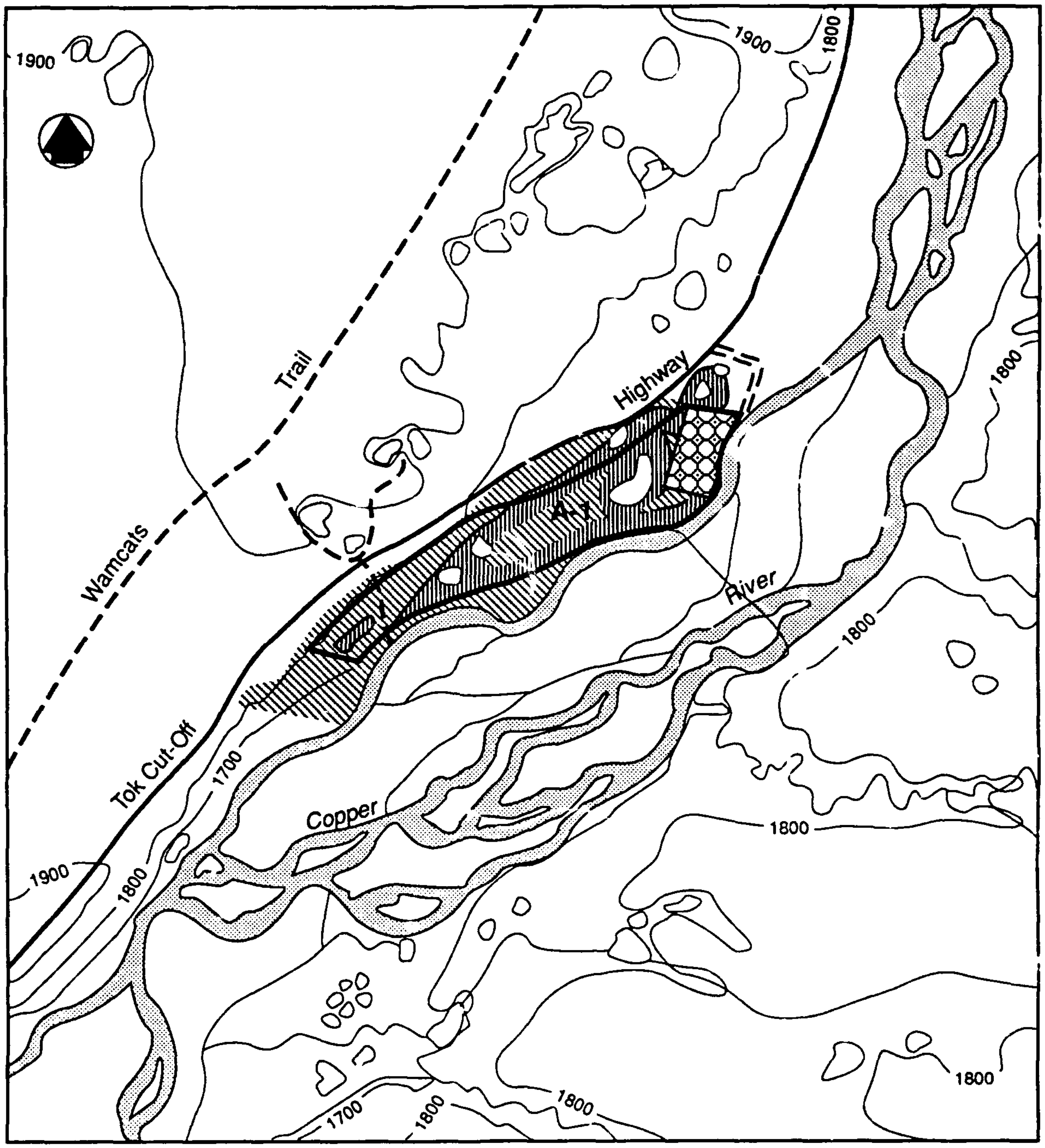
TABLE 3.9-1 ARCHEOLOGICAL SITES ASSOCIATED WITH BORROW AREA P-1

SITE	DESCRIPTION
GSA-11	Early historic or late pre-historic hearth
GSA-12	Historic and recent site with several loci; fish camp, food caches and large number of relics
GSA-14	Seasonal Native fish camp
GSA-15	Trapping site, may be equivalent to GSA-28
GSA-19	Food cache built in 1943
GSA-28	Native and non-Native trapping site, 1900's
G-16	Historic to modern camp and woodcutting site
GUL-219	Burial mound east of P-1
GUL-015	Historic settlement at mouth of Tolsona Creek

Source: AEIDC, 1991

relating to the prehistoric and protohistoric Ahtna period exist within the area's confines. The areas of greatest potential for such sites are along river margins and prominent overlooks.

Area A-1. The AHRS lists one site within this proposed material source on the basis of ethnohistorical information collected by de Laguna (1969). This site, GUL-018, is listed as an Ahtna settlement, but its reported location has not been verified in field surveys. Archeological field investigations undertaken in 1988 resulted in coverage of approximately 7 percent of the study area. Much of A-1 was previously burned over; as a result, visual reconnaissance of this area is more effective than it is in the other material source areas. Approximately 4 percent of this area was subjected to subsurface reconnaissance. Survey area boundaries are depicted in Figure 3.9-3.



SOURCE: U.S.G.S. Gulkana (B-2), 1964
AEIDC, 1988

.5 0 .5
SCALE IN MILES

	Proposed Borrow Area
	Existing Borrow Pit
	Cultural Resource Survey Areas
	Highest Potential for Discovery of Additional Prehistoric Habitation Sites

FIGURE 3.9-3. POTENTIAL BORROW AREA A-1 CULTURAL RESOURCES SURVEY AREAS 1988

28173-4

One possible prehistoric site was located during the survey, listed as GSA-023. This site consists of a level rectangular space bounded by low earthen berms, and is situated near the Copper River terrace edge. The features are suggestive of a house structure with possible attached rooms. Current information suggests that the potential for additional prehistoric habitation sites is greatest along the Copper River terrace (Figure 3.9-3). Such sites would have been associated with the spring hunting of waterfowl or small aquatic mammals.

Ethnohistorical sites may be expected in association with an early Ahtna trail crossing the area (Ahtna, 1988). Sites relating to the non-Native historical use of the area may be found which are associated with the historical Chistochina mining trail, portions of which were found during site surveillance.

Area A-4. The Bureau of Indian Affairs (BIA) conducted an archeological survey in the area in 1983, which was confined to a Native allotment surrounding the central gravel pit. The survey revealed evidence of extensive Native occupancy, including house depressions, cache pits, a smokehouse, hidden deposits, and graves. Other settlements are believed to exist in this area (de Laguna, 1969). Three sites are listed by the AHRS as GUL-023, GUL-024, and GUL-026.

Archeological investigations conducted in 1988 for the OTH-B program examined approximately 4 percent of the area. Slightly less than 2 percent of the area was subjected to subsurface investigation. Survey area boundaries are depicted in Figure 3.9-4. No prehistoric sites were identified during the 1988 field investigations, though a high potential for sites located within the area is suggested by its proximity to the confluence of the Chistochina and Copper rivers. No additional ethnohistorical sites were discovered during the survey, but others may exist in association with a prominent Ahtna trail through the survey area (Ahtna, 1988).

Historical resources identified during the 1988 investigations include a continuation of the Chistochina mining trail along the river terrace and a scattering of historical debris. The

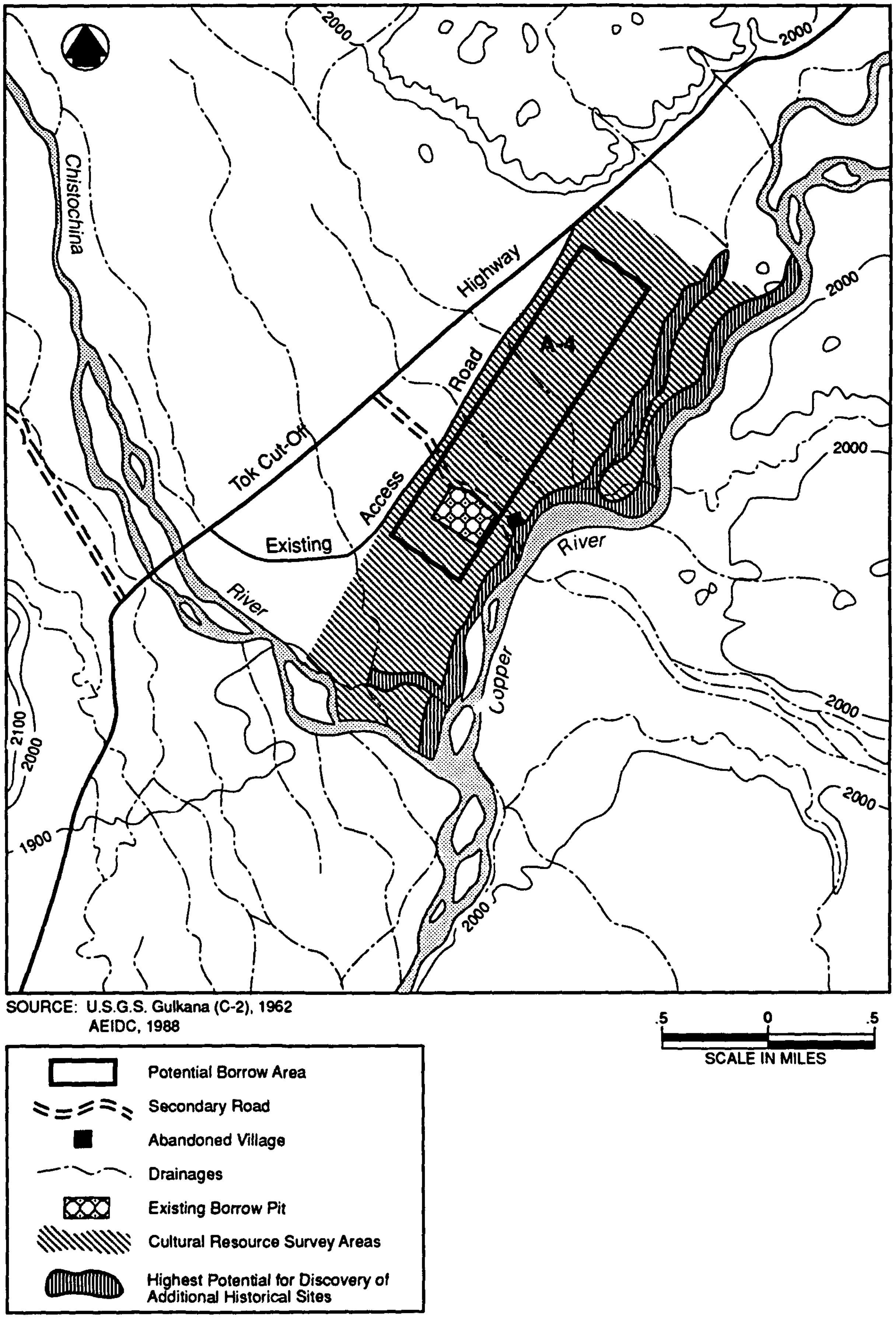


FIGURE 3.9-4. POTENTIAL BORROW AREA A-4 CULTURAL RESOURCES SURVEY AREAS 1988

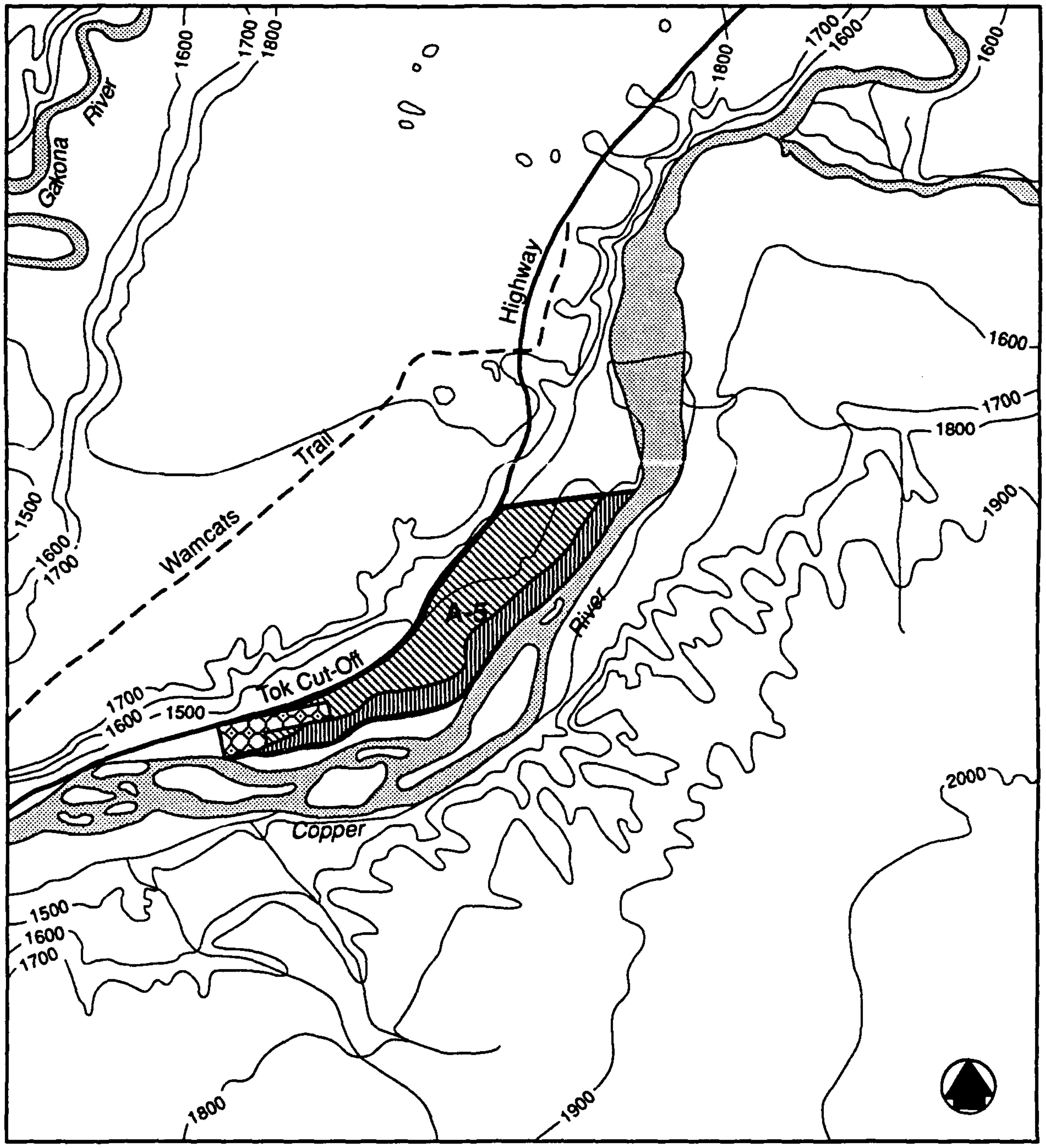
2817J-2

WAMCATS trail reportedly crossed the survey area, and two cabins associated with its use are said to be located within the Native allotment (Poston, 1988). The area's proximity to the Chistochina and Nabesna mining districts and their trail networks and the presence of a military "settlement" suggest a high potential for the discovery of additional historical sites. Areas considered to have the highest potential for the existence of cultural resources are illustrated in Figure 3.9-4.

Area A-5. No previous archeological surveys are known within the A-5 area survey boundaries. The Bureau of Indian Affairs (BIA) conducted investigations within the adjacent Native allotment and recorded two cemetery areas containing a total of six graves, which are listed as GUL-057 on the AHRS.

Field investigations undertaken in 1988 resulted in overall coverage of slightly more than 2 percent of the area, with both surface and subsurface examinations conducted (Figure 3.9-5). No prehistoric sites were uncovered in the 1988 survey, but the intensity of use of this area by modern Native fishermen may indicate significant potential for prehistoric fishing camps or other sites to exist (Figure 3.9-5). One ethnohistoric site was identified, located along the Copper River in the central part of the borrow area. Cultural remains consisted of a rectangular log foundation, presumably a base for erection of a canvas-walled tent. The two previously identified cemetery areas within the Native allotment suggest the potential for additional ethnohistorical resources.

No non-Native historical sites were previously reported within the survey boundaries, and none were located during the 1988 archeological investigation. The historical WAMCATS trail noted in P-1, P-2, and A-1 probably extends through this area, thus there is some potential for the occurrence of Euroamerican historical campsites.



SOURCE: U.S.G.S. Gulkana (B-3), 1977
AEIDC, 1988

.5 0 .5
SCALE IN MILES

	Potential Borrow Area
	Existing Borrow Pit
	Higher Cultural Resource Site Potential
	Significant Potential for the Existence of Prehistoric Fishing Camps or Other Sites

FIGURE 3.9-5. POTENTIAL BORROW AREA A-5 CULTURAL RESOURCES SURVEY AREAS 1988

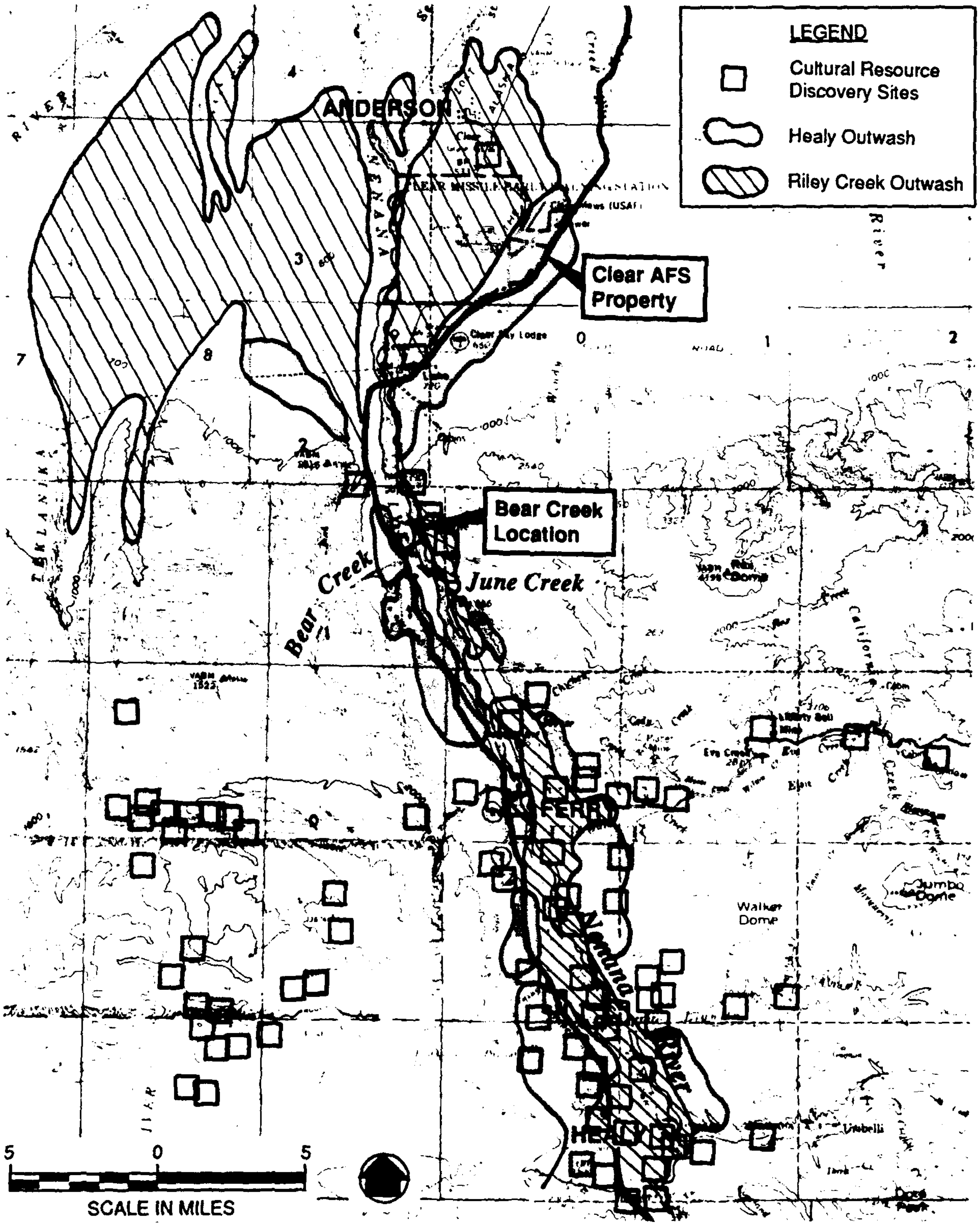
2817J-6

3.9.2 Clear Site

Prehistorical Period. The Nenana River basin area is considered archeologically significant. Over 100 pre-historic and historic sites have been discovered along the length of the Nenana River which runs essentially northward out of the Alaska Range from the town of Cantwell and flows into the Tanana River near the town of Nenana (Approximately 140 miles). The sites discovered to date range from a recent 100 year old site to an ancient 12,000 year old site. Some of the sites are reported to be among the oldest cultural remains found on the continent (Goebel et al., 1991, Powers and Hoffecker, 1989, Powers et al., 1990). Earlier sites in the Nenana River basin are Paleodian in nature and have many similarities to those found on the high plains of the western U.S. (Goebel et al., 1991). Additional findings in the region include: Denali Complex microblade sites (10,000 to 7,000 years old); Northern Archaic sites (6,000 to 3,000 years old); and, Late Denali sites (3,000 to 1,000 years old). In addition, many late pre-historic and historic sites have been found in this region (Braid et al., 1991).

Of all the archeological sites found in this region, very few are located on the section of the Nenana River between the Rex Bridge and the town of Nenana (Figure 3.9-6). This is particularly true for the older pre-historic sites. This observation stems from research in the area being concentrated in the foothills south of Walker Dome (Goebel et al., 1991, Powers and Hoffecker, 1989, Powers et al., 1983, 1990). Figure 3.9-6 shows the locations of the archeological discoveries in the region.

Ethnohistorical and Historical Periods. Use of the Nenana River region by Native Alaskans has been well documented by ethnohistorians. The Athabaskan "Nenana Band" used the Nenana River Valley as a transportation route from the summer salmon fishing areas to the autumn caribou and Dall sheep hunting grounds in the foothills north of the Alaska Range. This use of the area is documented in the late 1800's, but probably goes back into late pre-historic times (Kari, 1983). This extensive use of the area suggests that numerous campsites should be present on Clear AFS and at the Bear Creek location.



SOURCE: Braid, 1991

FIGURE 3.9-6. KNOWN CULTURAL RESOURCE SITES, GLACIAL OUTWASHES, AND THE LOCATION OF THE HAARP IN THE NENANA RIVER VALLEY

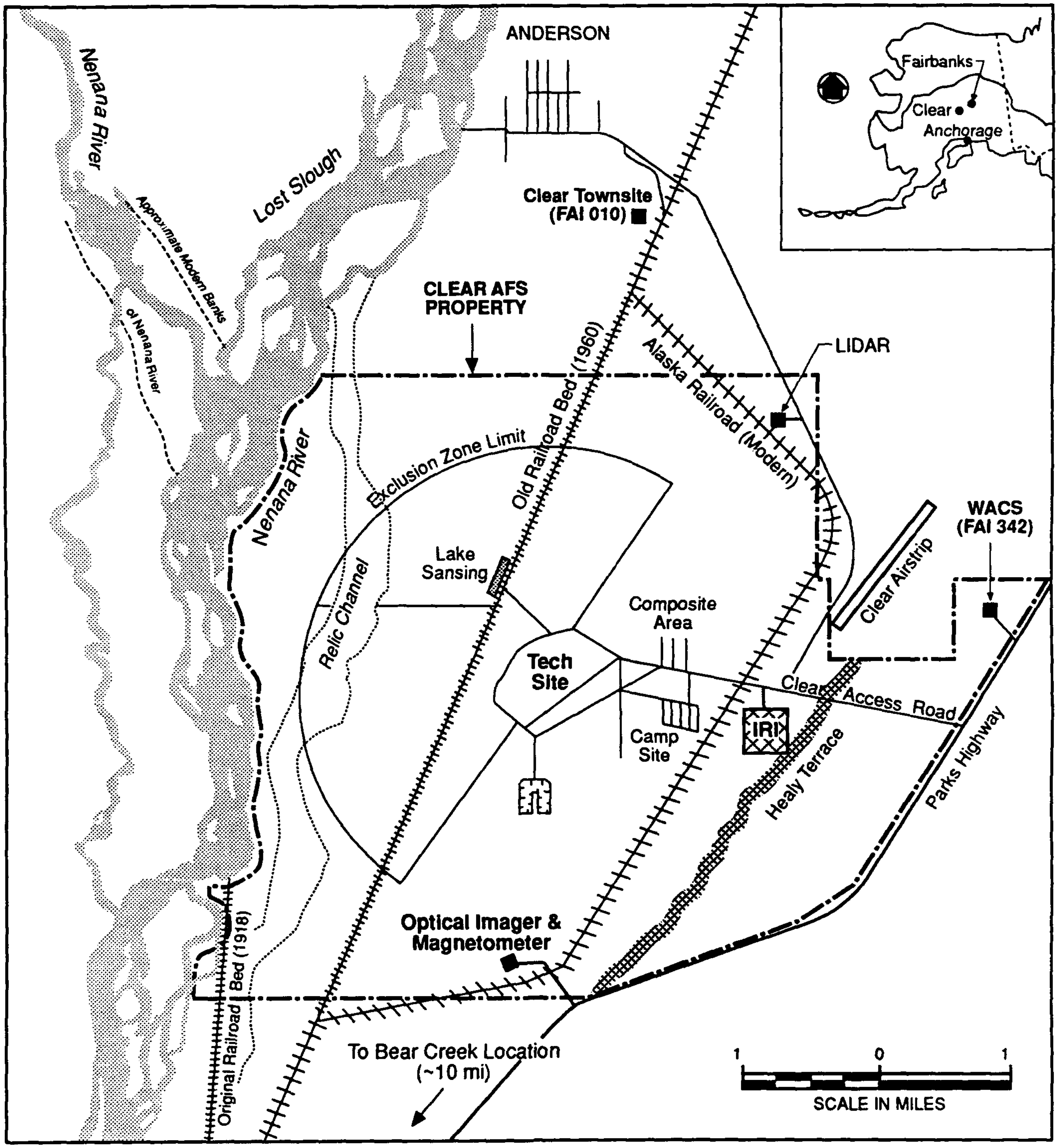
Linguists have also traced Nenana River place-names to the current Clear region, including: Ana'notoxtadh'onh equating to Lost Slough (Thompson, 1979); Ninano' equating to Nenana River (Thompson, 1979); and, Totthaghi'odenh equating to Rex Dome (Kari, 1983; Thompson, 1979). This suggests native familiarity with the region.

Euroamerican use of the Clear area appears to be limited mainly to the construction of the Alaska Railroad circa 1910, followed by the construction of the BMEWS site by the Air Force in the 1950's. The Alaska Railroad tracks run northward from Healy to Nenana parallel to the Nenana River near Clear AFS. This section of the tracks was constructed between 1917 and 1919. A section of the tracks was destroyed during construction in 1918 when the Nenana River main channel suddenly moved eastward through what is now Lost Slough. This channel change destroyed about 20 miles of tracks, prompting the rebuilding of the tracks to the east, further from the Nenana River (Figure 3.9-7).

Associated with the rebuilding of the tracks, Clear Railroad Station was constructed in 1918. A replacement to this house was constructed in the early 1930's, with a small village growing up around it (Orth, 1971). The Clear Railroad Station Townsite is located adjacent to the existing railroad tracks about 1.5 miles north of the northern boundary of Clear AFS. This site has been determined eligible for inclusion on the NRHP.

A roadhouse is also reported to have existed in the area, although the exact location is not known (Braid et al., 1991). The "Old Jap Roadhouse" reportedly provided room and board services to railroad construction workers in the area (Braid et al., 1991). The 1991 cultural resources survey of the area turned up no evidence of its existence.

The railroad tracks in the immediate area were once again moved eastward in 1960-61 to make room for the BMEWS installation. Both the 1918 location and the newly relocated track section now curving around the high-intensity radar installation are evident from the air.



SOURCE: Braid, 1991

FIGURE 3.9-7. CLEAR AFS PROPERTY WITH HISTORICAL INFORMATION AND SITING INFO ON HAARP FACILITIES

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The Clear area was first utilized by the military after World War II when a large airstrip was constructed to support B-36 bombers (Jacobs and Woodman, 1976). Through an evolutionary process with the build-up of the Cold War, this site became a Master Ground Control Intercept (MGCI) as part of the Air Force Alaskan Interim Air Defense System (Cloe and Monaghan, 1984). This system was replaced by BMEWS in 1961. The Clear BMEWS site is designed to detect the launching of intercontinental ballistic missiles from the asian continent headed toward the U.S. via the north polar route. The BMEWS program consists of three major installations, one of which is Clear AFS, Alaska. The other two are located in Greenland and the United Kingdom. They collectively cover the northern region of North America and provide a 15 minute launch warning to the U.S. The site is a product of the Cold War between the U.S. and the former U.S.S.R.

The small microwave relay station located in the northeast corner of Clear AFS property was part of the White Alice Communication System and has been determined to be eligible for placement on the National Register of Historic Places (Braid et al, 1991). Clear AFS and the BMEWS Program are also products of the Cold War and could receive similar historical treatment in the future.

Known Cultural Resources in the Clear Region. There are two known sites in the Clear region that are currently eligible for inclusion on the National Register of Historic Places (SHPO, 1992). They include the White Alice Communication System (WACS) tower (FAI 342) located in the northeast portion of the Clear AFS property and the Clear Railroad Station Townsite (FAI 010), located adjacent to the railroad tracks and about 1.5 miles north of the northern military property boundary (SHPO, 1992) (see Figure 3.9-7). Neither the Clear Townsite nor the WACS tower is on military property, although the WACS site is surrounded by Clear AFS property. The WACS tower was sold to ALASCOM in 1983 to support their communication system throughout the state of Alaska. Both sites are eligible for NRHP inclusion due to their role in the State of Alaska's history.

A cultural resources survey of the Clear AFS was conducted in 1992 by the Oak Ridge National Laboratory and the University of Alaska Fairbanks (Braid et al., 1992). The survey was not conducted expressly for the HAARP program, but was intended to provide the Air Force with an indication of the level of pre-historic, ethnohistoric and historic cultural resources at the site. The result of the survey concluded that the Clear AFS site has a high probability of containing cultural resources, particularly that area between the existing railroad trackage and the Parks Highway on what is referred to as the Healy Terrace (Figure 3.9-7). This area of the station is relatively undisturbed and many archeological finds may have been preserved. In contrast, many of the other areas of the station have been disturbed during the construction of Clear AFS which included stripping the top layer of loess mantle from the site to access the underlying gravel and sand material. Discoveries in this previously disturbed region are considered unlikely.

The Bear Creek site currently has no known existing or eligible NRHP property in the area (SHPO, 1992), although cultural resources surveys of the Bear Creek location have not been conducted. However, general information from the area suggests an abundance of cultural resources sites in the Nenana River Valley (Braid et al., 1991). Figure 3.9-6 shows the extent of cultural resource discoveries in the area. Based on this information and the fact that the valley was historically used by the Nenana Band as a transportation route, it is highly likely that discoveries would be made in this region during construction of HAARP facilities (Braid et al., 1991).

Known Cultural Resources in the Borrow Material Areas. Existing borrow pits on Clear AFS would be utilized as material source areas for the construction of HAARP facilities on Clear AFS property. A discussion of known cultural resources in this area is presented above.

The location of borrow material areas for use in constructing the facility at the Bear Creek location is not known. Two options for obtaining gravel for this site seem probable. The first would be to use the borrow areas at Clear AFS and haul the required material to the Bear Creek location (approximately 24 miles, round trip). Known cultural resource sites at Clear AFS are

discussed above. The second, and possibly more probabe, option would be to use an off-site private or State of Alaska borrow pit closer to the Bear Creek location to obtain the required quantity. For this second option there is no known cultural resources as the site has not been established.

3.10 SUBSISTENCE

Subsistence consists of the non-commercial use of wild resources for a variety of purposes. In many sections of Alaska, it represents the means by which residents support their livelihood in whole or part, and enables Alaska Natives to continue engaging in traditional cultural and religious activities. The level of subsistence activity varies with cultural, traditional, and economic factors, as well as the availability of the resources.

An assessment of the potential impacts to subsistence which may result from construction and operation of the HAARP facility is being undertaken as part of the EIS. This analysis employs a total resource approach, and centers on the potential direct effects on resource species. It also considers the potential indirect effects on resource species associated with alteration or loss of habitat. Economic considerations are addressed in the analysis.

The region associated with the Gakona site that is considered in this analysis includes the site and surrounding areas of the Copper River Basin adjacent to the site where subsistence resources and their harvest might be influenced by the facility's construction or operation. This includes locations identified as potential sources of gravel and the associated haul road to the site. The Clear site under consideration includes the Clear AFS property, the Bear Creek location, and surrounding areas in the Nenana River Basin.

The review of existing conditions includes a historical perspective on subsistence, its relationship to regional and local economies, regulatory considerations, and a description of current subsistence practices and resources in the area. The review utilizes information generated during 1988 by the University of Alaska's Arctic Environmental Information and Data Center (AEIDC, 1988c), in cooperation with the Alaska Department of Fish and Game and the United States National Park Service. The comprehensive household surveys which were conducted during the study are still considered to be the premier information base on subsistence activities in the region (ADFG, 1992g). Additional information from recent years was obtained from ADFG to assess the current status of subsistence resources.

3.10.1 Historical Perspective on Subsistence

The harvest of wild resources has been an integral part of the history of the region's Native as well as non-Native residents. It formed the basis for the social, cultural, and economic systems of early societies, whose survival was dependent upon these resources. Their activities closely followed the seasonal migration and availability of game and plant species. This close association resulted in the incorporation of the harvesting of wildlife and the giving and sharing of wildlife products into religious practices and cultural traditions which remain today.

Non-Native groups which began entering the area in the 1800's to pursue furs and minerals were also dependent on the natural resources for their existence, thus their culture embraced a subsistence lifestyle as well. The influx of these people resulted in new pressures on both the natural resource base as well as the Native culture, resulting in new trade practices and an evolution in subsistence lifestyles.

During the 1980's, an estimated 110,000 people annually participated in subsistence activities statewide (ADFG, 1990). Of these, approximately 50,000 were Alaska Natives, and 60,000 non-Natives. While not all of these people actively harvested resources, most rural residents participated in the traditional sharing of an estimated 45 million pounds per year of wildlife products. Relative to the total harvest of natural resources statewide by all categories, subsistence accounted for 4 percent of total harvest compared with 95 percent commercial and 1 percent by sportsmen.

3.10.2 Regulatory Management of Subsistence

The increasing pressure on Native culture and wildlife resources exerted by the influx of population, commercial endeavors, and other external forces resulted in attempts to protect the traditional role of subsistence. In 1960, amendments to the Alaska Fish and Game Code included provisions for "subsistence fishing" (Brelsford, 1990). During the 1970's, the state of Alaska established policies which gave priority to subsistence uses of fish and game, and in 1978

statutes were passed by the legislature which established criteria to define such uses. A subsistence research program was established within the Department of Fish and Game.

In 1980 the United States Congress passed the Alaska National Interest Lands Conservation Act (ANILCA), which established the federal policy on subsistence. Under Title VIII of ANILCA (16 United States C. 3111-3126), rural residents of Alaska were granted a priority for subsistence use of fish and wildlife resources on federal lands. This priority over non-subsistence uses (i.e. sport or commercial harvests) was afforded whenever it is necessary to restrict the taking of fish and wildlife to protect the viability of natural populations or their continued use. Subsistence use is defined under ANILCA as "the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation..." Other uses include arts and crafts, barter, and customary sharing and exchange of goods.

The subsistence program in Alaska is currently regulated by a dual system. Subsistence activities on federal public lands are regulated by the federal subsistence program pursuant to Title 8 of ANILCA. Federal lands account for approximately 65 percent of the total area of Alaska. The federal subsistence program is jointly administered by the U.S. Forest Service (36 CFR 242) and the U.S. Fish and Wildlife Service (50 CFR 100). The state subsistence program is not in compliance with Title 8 of ANILCA.

The state program continues to be the subject of ongoing legal and legislative debate. The outcome of this debate over the next couple of years will result in further changes to the state system (ADFG, 1992c).

3.10.3 Gakona Site

Current Subsistence Practices. Communities in the Copper River Basin are included in the state's Southcentral Region category for subsistence harvest data. This region had the smallest subsistence harvest during the 1980's relative to other regions in the state, with the total annual

harvest of 0.9 million pounds representing only 2 percent of the statewide total (ADFG, 1990). This was largely attributable to the low population density in the area and the tendency for users under the rural resident program to harvest in traditional, readily accessible areas surrounding their communities.

More than 90 percent of all households within the Copper River Basin who responded in surveys conducted in 1988 indicated that they regularly engage in the harvest of subsistence resources (AEIDC, 1988e). These surveys interviewed approximately 38 percent of the estimated total number of households in the Basin, and reached an average of 89 percent in communities smaller than 30 households. Residents of a number of these communities indicated that they pursued subsistence activities within a 5-mile radius of the candidate site for the HAARP facility.

The Copper River Basin communities are presently classified as rural under the federal subsistence program. Rural residents that comply with federal customary and traditional use determinations are eligible to participate in subsistence activities on federal public lands. In addition, National Park Service regulations govern which communities or individual residents qualify for subsistence uses within national parks and preserves.

Economic Considerations. The economy of communities in this region (Section 3.8) has experienced cyclic peaks in activity associated with mining and construction activities (such as the construction of the Glenn Highway and Trans-Alaska Pipeline), but for the most part wage employment opportunities are limited and are usually of a seasonal nature. For example, approximately 60 percent of applicants for subsistence permits in 1985 (moose and caribou permits) from the 23 villages which comprise the Copper River Basin reported having insufficient income to purchase alternative foods (AEIDC, 1988e). For moose permit applicants from the three closest villages to the site (Chistochina, Gakona, and Gulkana), 75 percent reported having insufficient funds for such purchases. More than half considered the availability of such goods only slightly available or not available at all. Subsistence thus continues to represent a primary basis for support of the livelihood of area residents.

Where wage employment opportunities are available to one or more members of a family, the resulting condition is termed a "mixed, subsistence market economy" (ADFG, 1990). In many cases, a portion of disposable income is invested in the means to more efficiently pursue subsistence resources. These "subsistence technologies" include such hardware as fish wheels, gill nets, boat motors, and snowmobiles.

Caribou and moose, the most sought after big game species in the Gakona region, can be hunted by Alaskan residents. Furthermore, caribou hunting is only open to hunting by the so called Tier II Subsistence Permit. Tier II permits for an area are required for hunting when the state determines that game populations are not sufficient to satisfy the entire subsistence demand. Permits are issued to individuals based on dependence on game for ones livelihood, local residency, and on alternative resources. Hunting under a Tier II permit would not classify as a recreational activity.

Subsistence Resources. Table 3.10-1 lists common subsistence resources, which include a number of game and non-game species animals as well as various plants harvested for food and fuel. A description of the vegetation types that are found at the sites and surrounding area was included in Section 3.2. Animal populations found in these areas were described in Sections 3.3 (mammals) and 3.4 (birds). In general, the Gakona site provides relatively poor quality habitat for most the species listed in Table 3.10-1.

The principal subsistence resources harvested in the Copper River Basin are fish, moose, and caribou (AEIDC, 1988e). Harvest data for households in the adjacent villages of Chistochina, Gakona, and Gulkana are presented in Table 3.10-2. The data indicate that these categories represented 85, 88, and 91 percent, respectively, of the total subsistence harvest of food resources for these villages.

Fish species represented the largest percentage by weight, predominately consisting of sockeye and king salmon. Freshwater fish harvested for subsistence uses included grayling, trout, and whitefish. Bird species do not contribute significantly to local harvests, and notable use of

TABLE 3.10-1 COMMONLY USED SUBSISTENCE RESOURCES

Large Mammals
- Moose
- Caribou
- Black bear
- Brown bear
- Dall sheep
- Mountain goat

Small Mammals
- Porcupine
- Arctic ground squirrel
- Lynx
- Snowshoe hare
- Beaver
- Coyote
- Red fox
- Marten
- Marmot
- Mink
- Muskrat
- Weasel
- Wolverine
- Gray Wolf

Fish
- Sockeye (red) salmon
- King (chinook) salmon
- Silver (coho) salmon
- Arctic grayling
- Whitefish
- Northern Pike
- Sucker
- Lake trout
- Rainbow trout
- Burbot

Birds
- Ptarmigan
- Ruffed grouse
- Spruce grouse
- Canada goose
- White-fronted goose
- Mallard
- Northern pintail
- American widgeon
- Scaup

Berries
- Blueberry
- Highbush cranberry
- Lowbush cranberry
- Crowberry
- Red currants
- Black currants
- Raspberry
- Nagoon berry
- Cloudberry

Mushrooms
- Orange delicious
- Shaggy mane
- Orange boletus
- Meadow mushroom
- Morel
- Puff ball

Wild Vegetables
- Sourdock
- Fireweed
- Watercress
- Lambsquarter
- Chickweed
- Wild chive
- Indian potato
- Sweet vetch
- Rose hips

Trees
- Spruce
- Balsam poplar
- Birch

Shrubs
- Alder
- Green willow shoots
- Willow catkin

Source: ADFG, 1986

TABLE 3.10-2 PRINCIPAL SUBSISTENCE RESOURCES FOR VILLAGES IN GAKONA REGION

Mean Household Harvest
(Edible Weight(lbs)/Percent of Total Harvest)

VILLAGE	SALMON	CARIBOU	MOOSE	FRESH-WATER FISH	TOTAL
Chistochina	353/50	65/9	147/20	40/6	603/85
Gakona	92/32	63/22	69/24	28/10	253/88
Gulkana	262/56	46/10	90/19	26/6	423/91

Source: AEIDC, 1988e

waterfowl is limited to areas with large Native populations (USAF, 1989b). The most important bird species are grouse and ptarmigan. Harvest of fur-bearing species is also somewhat limited, with coyote, red fox, beaver, gray wolf, and marten the most sought after species.

3.10.4 Clear Site

Current Subsistence Practices. Communities in the Nenana River Basin that utilize area subsistence resources include Anderson-Clear, Healy, and McKinley Park, as well as other small settlements. This region falls under the State's Yukon River Drainage area, which is a massive area including most of interior Alaska. The average annual subsistence harvest for interior Alaska during the 1980's included about 4.7 million pounds, which represents about 12 percent of the statewide total harvest(ADFG, 1990). This relatively low interior Alaska harvest is a reflection of the sparseness of the areas's human population. Of this total take, approximately 70 percent was from fish, and 25 percent from game, with sea mammals, berries, and other resources making up the remainder.

A survey of three communities in the Nenana River Basin (Healy, Anderson-Clear, and McKinley Park) by the Alaska Department of Fish and Game (January, 1988) indicated that both the Clear AFS property and the Bear Creek location are used for the harvesting of subsistence resources (ADFG, 1992h). At the Clear AFS property bear and moose hunting is conducted by locals, along with wood and berry gathering and trapping activities. No sheep or caribou hunting, or salmon or non-salmon fishing was reportedly conducted on the Nenana River in the immediate area of Clear AFS, although all three activities were identified within the region. Salmon and non-salmon fishing is carried out on the lower reaches of the Nenana River near its confluence with the Tanana River at the community of Nenana. This activity extends back upstream approximately 14 miles almost to the town of Anderson. Caribou hunting is confined to the foothills of the Alaska Range located about 15 miles south of Clear AFS, while sheep hunting is carried out in the steep mountainous regions of the Alaska Range located further to the south.

The Bear Creek location is situated in a region that is somewhat more important than Clear AFS from a subsistence perspective. This area is located in the foothills of the Alaska Range and according to the ADFG survey (1990) it is used by locals for subsistence activities relating to bear, moose, and caribou hunting, as well as trapping and wood and berry gathering, and fishing for non-salmon species (ADFG, 1992h).

Although information is available on the areas used for subsistence activities as presented above, there is no information available on the level of use or the relative importance of subsistence in the areas (ADFG, 1992h). However, from a general standpoint, areas receiving the highest levels of use, and therefore being the most important to the users, are near highways or airstrips, on river corridors, or near trails or logging roads (ADFG, 1992c). Using this criteria, it follows that the areas under consideration for siting of the HAARP equipment will be in areas of high subsistence use and elevated importance.

Economic Considerations. Like much of Alaska, the economy of this region has also experienced a boom and bust cyclical pattern, with the boom periods typically being centered

around major construction projects such as roads, railroads, or defense or industry installations. However, unlike some areas, the Nenana River Basin or Parks Highway corridor does have an employment base. The Usibelli Coal Mine in Healy, Clear Air Force Station in Clear/Anderson, the barge and tug operations on the Tanana River in Nenana, and tourist related services for the community of McKinley Park provide a cash-type economy base for many of the local residents employed by these enterprises (ADFG, 1992c). ADFG refers to this system as a "mixed subsistence-market economy".

The importance of the subsistence economy to the local residents varies greatly due to the influence of the local industries on certain individuals and micro-communities. For instance, individuals that are employed at Clear AFS or the Usibelli Coal Mine might have a high monetary income with subsistence playing a relatively minor or non-existent role in their economic well-being. Conversely, other individuals might have a low monetary income and therefore, subsistence would play a major role in their family economic picture (ADFG, 1992c).

Subsistence Resources. Table 3.10-1 lists common subsistence resources, which include a number of game and non-game species animals as well as various plants harvested for food and fuel. A description of the vegetation types that are found at the sites and surrounding area was included in Section 3.2. Animal populations found in these areas were described in Sections 3.3 (mammals) and 3.4 (birds). The quality of habitat at the Clear site for subsistence harvested resources listed in Table 3.10-1 is, in a general sense, good.

Fish are a minor component of the local subsistence resource. The Nenana River has natural runs of chum and coho (silver) salmon, plus an enhancement program for king salmon was started in some tributary creeks in the lower Nenana River. The enhancement program was discontinued in 1988 (see Section 3.5.1). There is also an enhanced run of coho (silver) salmon in June Creek located near the Bear Creek site as a result of a surplus stocking program, which was discontinued in 1988 (see Section 3.5.1).

Thus, the reliance of local subsistence users on game is probably higher than on fish in this region of Alaska. This would include, in the large game category, moose, caribou, black and brown bear, and to a lesser extent sheep. An abundance of small game is present at the site (see Section 3.5.1) that would certainly provide additional sources of subsistence. Birds are also a possible significant contributor to subsistence harvests (USAF, 1989a).

3.11 RECREATION

This section describes the existing recreational resources and activities in the Gakona and Clear regions. Both of the sites are located close to major national parks, and recreational activities are of the outdoor and wilderness variety. Because of the sub-arctic climate of both these regions, it is understandable that recreation is largely, although not exclusively, seasonal in nature.

3.11.1 Gakona Site

The natural and scenic resources in the Gakona region offer a variety of recreational experiences including sight-seeing, photography, camping, backpacking, mountain climbing, rafting, fishing, and hunting. This variety of recreational opportunities attracts both Alaskan residents and non-resident visitors. The vast majority of visitors to the Gakona region are sightseers who pass through on their way to other destinations (USAF, 1989a). These would include visitors from Canada heading for destinations in the vicinity of Anchorage and visitors off-loaded from the state ferry system in Valdez heading for points north. Other visitors to the Gakona region are Alaskan residents and non-residents who come to the area for some specific outdoor activity, particularly fishing and hunting.

Recreational resources in the Gakona region are managed by both federal and state agencies. The federal agencies are the National Park Service (NPS), the United States Bureau of Land Management (BLM), and the United States Fish and Wildlife Service (USFWS). The principal state agencies are the Alaska Department of Natural Resources (ADNR) Division of Parks and Outdoor Recreation and the Alaska Department of Fish and Game (ADFG). Principal federal and state recreation lands in the vicinity of the site are shown on Figure 3.11-1.

The NPS manages the Wrangell-St. Elias National Park and Preserve, an area of 13.2 million acres that ranges from the Copper River on the north and west to the Canadian border on the

east. Access to the interior of the park is provided by the Nabesna Road off the Tok Cut-Off near Slana, and by the McCarthy Road off the Old Edgarton Highway near Chitina.

The BLM oversees the Gulkana National Wild and Scenic River (extending from Paxson to Sourdough) as well as several campgrounds in the vicinity of the Gakona site (Figure 3.11-1). Along the Richardson highway and at Tangle Lakes are five BLM facilities with a total of 65 camp sites. In addition, a BLM trail that runs northward from the Tok Cut-off to Fox Lake crosses directly through the Gakona site. Accurate counts of trail usage are not available; hikers and fishermen travel on the trail in summer and trappers use this trail in winter (USAF, 1989a).

The Alaska Division of Parks and Outdoor Recreation manages state recreation sites in the Copper River Basin. Figure 3.11-1 shows four state recreation sites having developed campsites. Several additional recreation sites with undeveloped camping areas also occur in the general vicinity.

Visitor count data provide a basis for understanding the extent of recreational activity in the Copper River Basin. In July, the peak month of the tourist season, visitor-days at state recreation sites are approximately 150,000 in the Copper River Basin (USAF, 1989a). In general, non-residents outnumber Alaska residents by two to one. The Gulkana National Wild and Scenic River was used by about 3,000 fishermen and rafters each year in 1987 and 1988. Total visitor- days were approximately 19,000 in 1987 and 22,000 in 1988 (USAF, 1989a).

Use of the regional fishery resource is substantial according to surveys conducted by ADFG. Statewide, about 70 percent of all sport fisherman were Alaska residents and 30 percent were non- residents (USAF, 1989a). Most Alaska residents were from the Anchorage area while less than one percent (or 1,500 sport fishermen) were from communities in the Copper River Basin. In 1986, use of the Glennallen area (including Lake Louise) totaled an estimated 51,000 angler-days (USAF, 1989a).

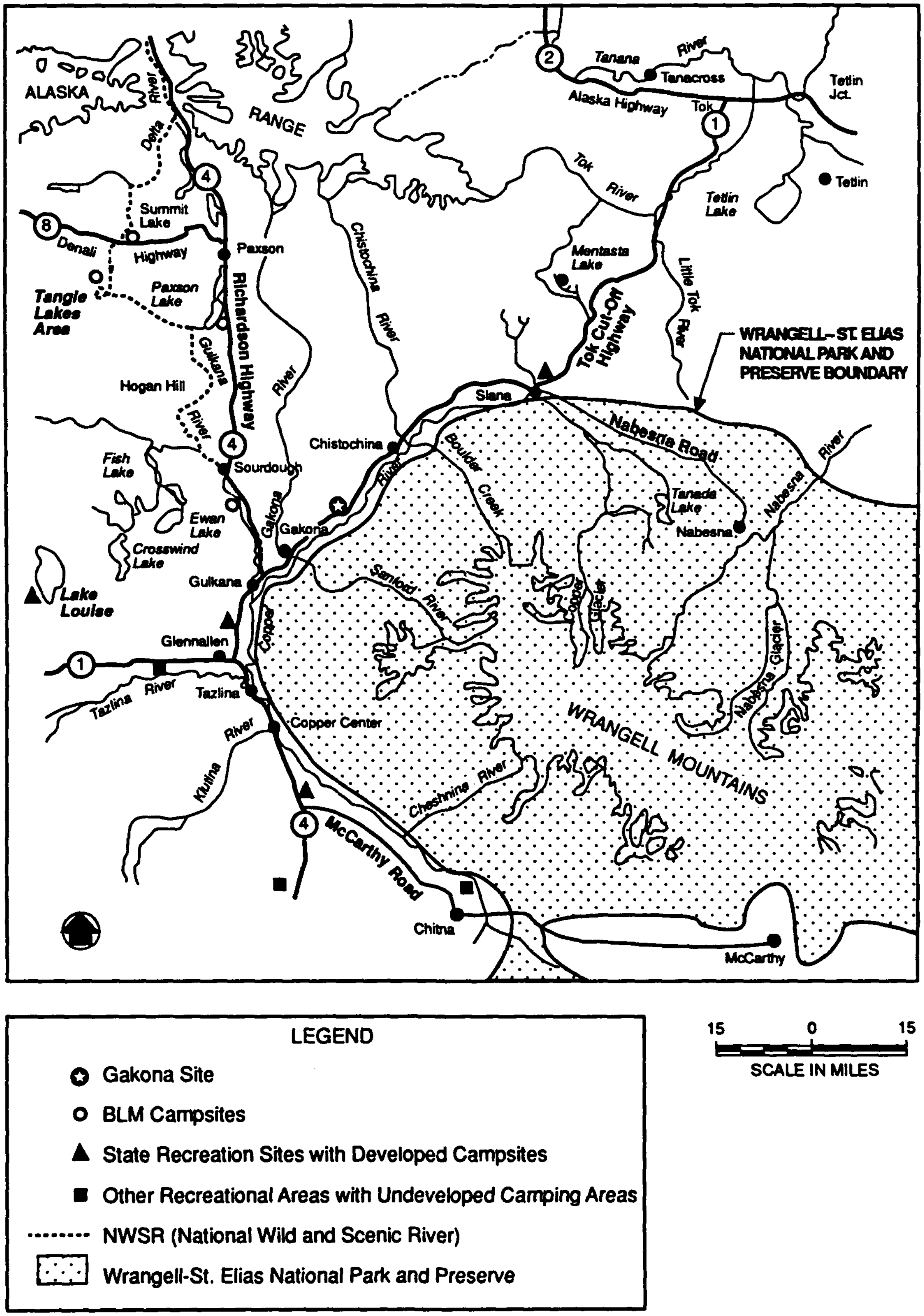

FIGURE 3.11-1. RECREATION RESOURCES IN THE VICINITY OF THE GAKONA SITE

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The contribution of sport fishing to the local economy can be estimated from the findings of a 1986 survey of sport fishing activity in south-central Alaska (USAF, 1989a). Total expenditures associated with sport fishing for all anglers in the Glennallen area were estimated at $2.1 million in 1986. Alaska residents fishing in the Gulkana River spent as much as $55 per day. Non-Alaskan anglers who fished in the Glennallen area reported spending an average of $130 per household per fishing day. Of that total, it is likely that only $90 to $100 was spent in the local area (USAF, 1989a).

Recreational hunting in the Copper River Basin is fairly common, particularly for caribou and moose. This area of Alaska is in game management unit 13, with the GMU sub-unit being 13C for the actual Gakona HAARP site. Some areas of GMU 13 are managed through special restrictive regulations, but GMU 13C is not among them. Table 3.11-1 is a summary of hunting regulations for the area for the more commonly hunted species, as taken from ADFG 1992-93 Hunting Regulations.

Moose, and to a lesser extent bear, hunting are common recreational activities. However, the short open season for moose hunting (see Table 3.11-1) and the requirement on the sex and size of the animal is an indication of both the level of hunting pressure and the overall importance of it from a recreational standpoint. Other furbearers and small game species such as gray wolf, coyote, wolverine, lynx, squirrel, and snowshoe hare can be hunted in the region, along with ptarmigan and grouse.

The level of hunting activity in the Gakona region is estimated to be rather substantial. For instance, hunting activity in 1984 by urban Alaskans was estimated to have been 370 to 1,120 households in the Copper River-Wrangell-Valdez area and 700 to 1,640 households in the Lake Louise area (USAF, 1986a).

TABLE 3.11-1 HUNTING REGULATION SUMMARY FOR GMU 13 GAKONA SITE

Species	Bag Limit	Resident Open Season	Non-Resident Open Season
Black Bear	3	NCS	NCS
Grizzly Bear	1 per 4 years	9/10-5/31	9/10-5/31
Caribou	1[1]	8/10-9/20	8/10-9/20
Moose	1 bull[2]	9/5-9/11	9/5-9/11

NCS = No Closed Season: NOS = No Open Season
[1] Tier II subsistence permit required
[2] 36 inch antlers required, harvest ticket required
Table represents state regulations for recreational hunting, although these regulations may apply in part to subsistence hunters. Harvest regulations stated are for 1992 and are subject to change from year-to-year.

Available data indicate that recreational activity in the Copper River Basin has been steadily increasing over recent years (USAF, 1989a). Overall, recreational activity is expected to continue to increase, with local residents the most intensive users.

3.11.2 Clear Site

The Clear region, including the Bear Creek location and the Nenana River Valley provides a wide variety of recreational experiences to both the Alaska resident and non-resident visitor to the state. Recreational activities in the region include sightseeing, camping, rafting, backpacking, mountain climbing, photography and wildlife viewing, berry picking, hunting, and fishing. There are some potential management conflicts between subsistence use and recreational uses which make these two issues interdependent (see Section 3.10 Subsistence).

Recreational resources in the Clear region are managed by both federal and state agencies. The federal agencies are the NPS, BLM, and USFWS. The principal state agencies are the ADNR,

and ADFG. Principal federal and state recreation lands in the vicinity of the site are shown on Figure 3.11-2.

The NPS manages the Denali National Park and Preserve, an area of about 6 million acres. Road access to the interior of the park is controlled by the NPS. Use of the Denali Park Road is restricted to NPS concessionaire buses and one tour company (Tundra Wildlife Tours) which provides all day (in-and-out) tours of Denali National Park. Passes to ride the buses must be purchased at the park entrance on a first come - first serve basis. A very limited number of special vehicle passes are provided to residents of Kantishna (a small community at the west end of the park road) which allows them to use the road with their private vehicles to access their homes.

The Alaska Division of Parks and Outdoor Recreation manages state recreation sites in the Nenana River Basin (Figure 3.11-3). Several recreation sites with undeveloped camping areas also exist in the general vicinity. Private campsites and RV parks are located in communities throughout the Parks Highway region.

The Parks Highway runs through the Clear region and is a major Alaskan thoroughfare linking the two major population centers of the state; Anchorage and Fairbanks. The Parks Highway also runs by the entrance to Denali National Park and Preserve; one of the most visited sites in the state of Alaska. Clear AFS lies 47 road miles north of the park entrance, and the Bear Creek location lies 32 road miles north of the park entrance. The highway is used extensively during the summer months by tourists in cars, campers and recreational vehicles, and in tour buses. During winter the traffic load is reduced.

The Alaska Railroad tracks runs parallel to the Parks Highway through the Nenana River valley and across the lowlands of the Nenana River basin. The Alaska Railroad provides daily service in the summer between Fairbanks and Anchorage (and vice versa) with scheduled stops at the Denali Park entrance. During the winter the passenger train service operates only on the weekends. The route is popular in the summer with tourists who ride the cruise ships to

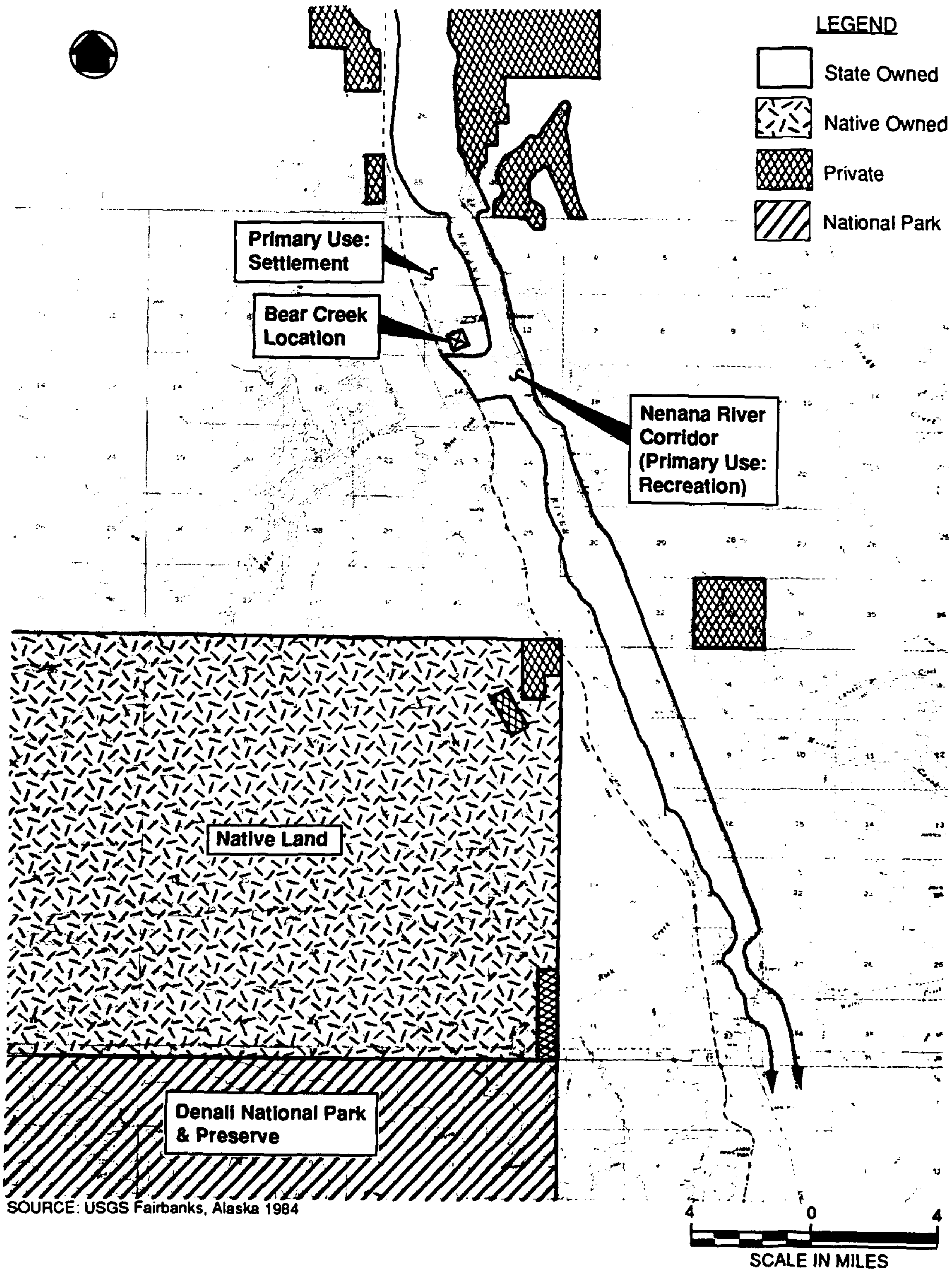
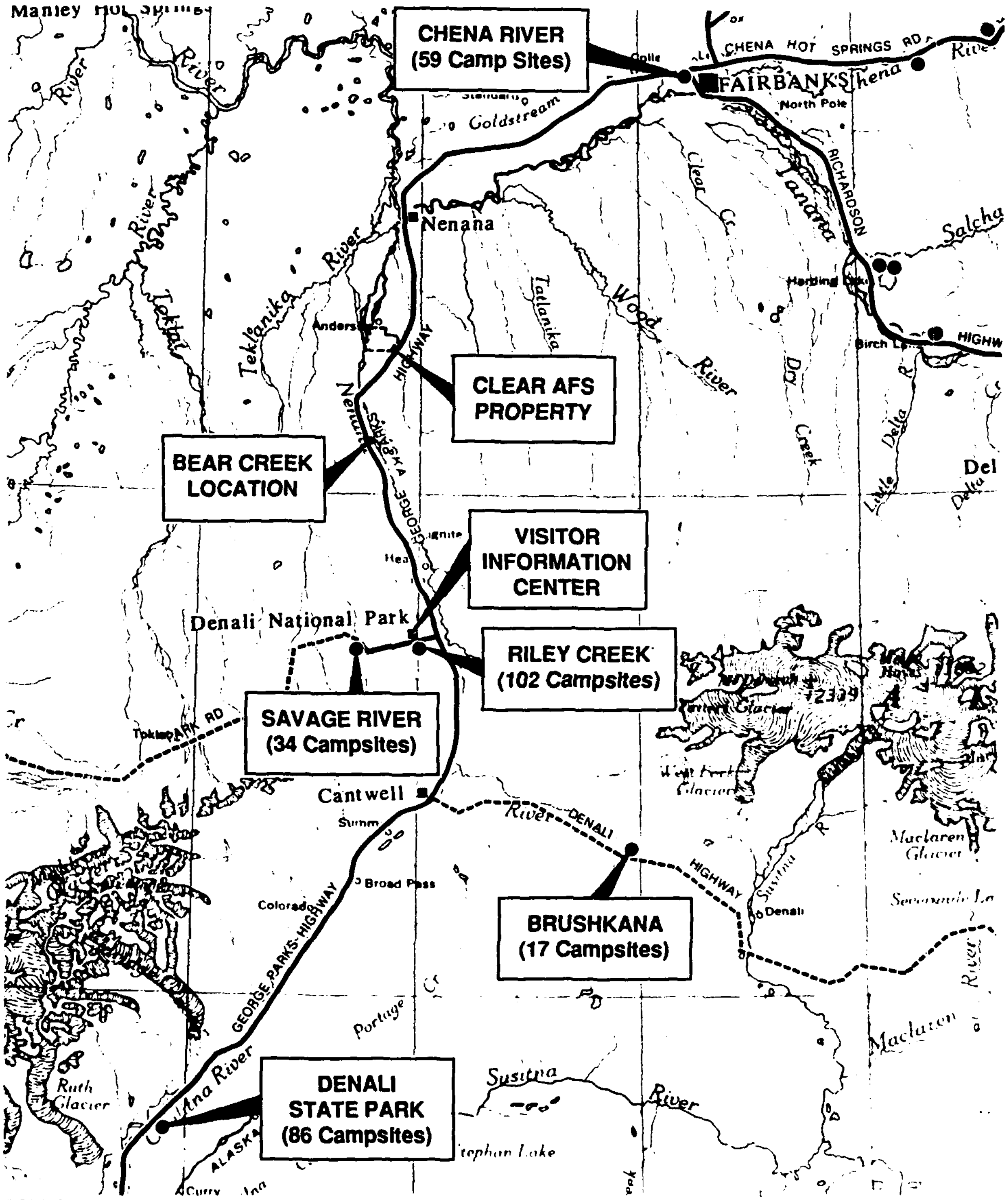


FIG. 3.11-2. MAJOR LAND OWNERSHIP AND USE PLAN FOR THE NENANA RIVER VALLEY AROUND THE BEAR CREEK LOCATION (ADNR, 1991)



SOURCE: Alaska Public Lands Information Center

FIGURE 3.11-3. FEDERAL AND STATE RECREATION SITES IN CLEAR REGION

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southcentral Alaska ports and then travel the interior on trains, with stop-overs at Denali Park, Fairbanks, and Anchorage.

The Nenana River runs swiftly out of the Alaska Range with sections of Class III and IV rapids. The river is used extensively in the summer for rafting trips that originate in the McKinley Park area and take out at the Healy Bridge before passing the Bear Creek location (NPS, 1992b). Several companies in the area offer these whitewater river rafting adventures and advertise them as scenic and wilderness experiences. Rafting trips typically range from 2 to 6 hours, with the longer trips originating further up the drainage toward Cantwell (NPS, 1992a, 1992b). There are six NPS licensed rafting companies in the McKinley Village area, with several other non-licensed companies also operating on the Nenana River. This section of the river is also used for commercial powerboat trips.

Downstream of this the Nenana River is used relatively infrequently for float trips or powerboating (ADNR, 1992c, NPS, 1992b). Approximately 50 floats per year are undertaken, with about half of them being recreational/sightseeing and the other half being for hunting access. It is estimated that only one or two commercial "tour-type" float trips per year would utilize this section of the river (NPS, 1992b).

The state of Alaska's Tanana Basin Area Plan recognizes the Nenana River Corridor as recreationally important, and plans to manage the river and surrounding area to "protect its scenic, recreational, and fish and wildlife values" (ADNR, 1991b).

Recreational and sport fishing in this region is generally considered to be fair compared to other areas of Alaska and therefore receives modest use. Non-salmon fishing opportunities include Dolly Varden, burbot and arctic grayling in the Nenana River and its tributaries (ADNR, 1991b). Several species of salmon (chinook, coho, and chum) run up the Nenana River and into spring-fed tributaries to spawn. This produces some recreational fishing opportunities in the area (ADNR, 1991b).

A fish hatchery on Clear AFS property provides enhanced fishing opportunities for rainbow trout and arctic char in man-made Lake Sansing. Fishing at Lake Sansing is open to the general public according to DOD policy, although due to the small size of the water body, use may be restricted (FSI, 1991). ADFG fishing regulations apply on Lake Sansing. Because the lake is man-made and is a cooling pond for the power generation station, it remains ice-free throughout the year. It is one of the only year-round fresh water fisheries in the state (ADFG, 1992f). Hunting and trapping are also important recreational opportunities in the Clear region.

The foothills of the Alaska Range are in the Clear Region and provide opportunities for hiking, backpacking, and sightseeing and photography, along with berry picking and other outdoor activities. Motorized recreational opportunities such as off-road vehicle (ORV) use and snowmobiling are also popular in the area (ADNR, 1991b).

Clear AFS offers recreational facilities and opportunities to station personnel, including softball, basketball, tennis, picnic grounds, nordic skiing, and snowmobiling. Hunting and fishing are also allowed within Clear AFS in designated locations that do not interfere with the Air Force mission (FSI, 1991).

Due to proximity of the Clear site, and particularly the Bear Creek location to Denali National Park and Preserve, it follows that this region is among the most important in the state from a recreational and tourism standpoint. Visitor count data from Denali National Park indicate a total visitation of 204,000 persons entering the park on the shuttle and tour buses in 1992 (NPS, 1992a). Total visitation to the park entrance is probably about three to four times this number, and has been increasing rapidly over the last couple of decades. Total recreational visitation to Denali National Park was about 600,000 as of the late 1980's (ADNR, 1991b), with a about 25 percent of that number using the park bus system. Campground use in Denali included about 20,000 campsite nights as of 1989, down from a 1978 high of 33,000 campsite nights (ADNR, 1991b). Backcountry use in Denali has stayed rather steady over the last decade at about 30,000 user nights (ADNR, 1991b).

Although the Nenana River supports fish life and has modest runs of salmon, the level of recreational fishing on the Nenana and its tributaries is very slight (NPS, 1992b). This is particularly true in the upper reaches near the proposed HAARP site.

Lake Sansing located on Clear AFS is a state run fish hatchery and permits fishing for rainbow trout, Dolly Varden, and to a limited degree arctic grayling. Because it is one of the only fresh waters in the state (certainly the region) that is able to be open water fished year round, Lake Sansing receives a fair amount of fishing pressure. Approximately 1000 people per year use the lake, particularly during the off-season, such as the early spring (ADFG, 1992f). Of the total fishing pressure, about half of it is the result of on-site personnel, with the other half coming from surrounding communities or further away (ADFG, 1992f). Fishing at Lake Sansing is open to the public. A free permit to fish on the base can be obtained at the main AFS gate.

Although no data were available on the exact hunting pressure that these areas received during hunting days, the Alaska Department of Fish and Game does have information on the densities of certain game animals in the area. Since high game densities often attract hunters, game density generally serves as a reasonable qualitative indication of hunting pressure. Moose densities in the Clear area are around 0.5 to 2.0 moose per square mile. Open season on moose is in early to mid-September, depending on the specific Game Management Unit (the Clear region includes both GMU 20A and 20C). Moose hunting is reportedly heaviest along the transportation corridors such as the Parks Highway and the Nenana River (ADFG, 1992a).

Black bear densities in the region are about 1 bear per 3 to 5 square miles. The hunting season extends throughout the year, but the bears are in their dens from about October though April. Bag limit for black bears is 3 per season (ADFG, 1992b). Grizzly bears are also present in the Clear area, with a reported density of 1 bear per 75 square miles and going up to about 1 bear every 35 square miles further to the south in the Alaska Range. Bag limits for grizzly bears in the region is limited to one bear every four years (ADFG, 1992b).

Even though there are two caribou herds in the region, hunting of caribou in this region is limited. The Delta caribou herd spends some time in the region, and some hunting around the town of Ferry has been done by residents not qualifying for subsistence use. However, due to declining populations of the herd, no hunting was permitted during the 1992 seasons. Hunting of the Denali caribou herd has been prohibited for the last decade or so (ADFG, 1992b).

Sheep hunting in the region is uncommon. Wolves in the area are both hunted and trapped. Wolf densities are about 1 wolf per 25 square miles. Annual harvest records indicate that 67 gray wolves were harvested in GMU 20A (east of the Nenana River), while 21 were taken in GMU 20C (west of the Nenana River). Hunting season for wolves extends from August 10 through April 30. Trapping season is from November 1 through March 31. Wolves are highly valued by hunters and trappers (ADFG, 1992b). Additional harvest records for the two game management units in which the Clear region falls indicate that beaver, lynx, river otter, and wolverines are commonly sought game.

There are no established public campsites in the immediate area of Clear AFS or Bear Creek. The nearest such areas are at the towns of Healy or Nenana, and are privately operated. The nearest publicly owned campsites are at the Denali Park entrance. They include Riley Creek and Savage River, as well as others located further in on the Denali park road. All of these campgrounds are extensively used and getting a site is difficult, at best.

The Tanana Basin Area Plan, as formulated by the ADNR, recommends that a state recreation area with a campground be established at June Creek located less than one mile from the Bear Creek location (ADNR, 1991a). However, other than the initial recommendation, there has been no follow-up activities to initiate the construction of such a facility (ADNR, 1992d).

The potential for recreation growth in the Nenana River Valley is fairly high due to its proximity to Denali National Park and Preserve and due to its location on a major Alaskan highway. The area south of Healy near the park entrance is probably the most susceptible to development, with possible encroachment down the valley toward Bear Creek. The state of Alaska plans to manage

the Nenana River Corridor based on its recreational significance which will probably limit and control development, but not exclude it.

The potential for recreational growth in the Clear AFS area is anticipated to be low due to the flat nature of the terrain, the relative lack of fishing opportunities, and the slow braided nature of the Nenana River in this region. Recreational use of the area is not anticipated to increase significantly in the coming years.

3.12 AESTHETICS

3.12.1 Aesthetic Criteria and Measures

Two factors play a key role in characterizing the visual resources of an area, scenic quality and viewer sensitivity. Scenic quality is perhaps best described as the overall impression retained after driving through, walking through, or flying over an area. Scenic quality reflects the physical features of the landscape, including both the natural features (such as landform, vegetation, water, and soils) and human modifications (such as roads, buildings, and utility lines) that have been made to the landscape. These features create the distinguishable line, form, color, and texture of the landscape composition, which in turn is judged for scenic quality using criteria such as distinctiveness, variety, harmony, balance, and uniqueness.

Because a landscape may have high scenic qualities but be remotely located, viewer sensitivity is a factor used to represent the value of the landscape to the viewing public, including the extent to which the landscape is viewed. Sensitivity includes a characterization of the range of viewers exposed to the landscape scene, when and from where they would see the resources, the angle and distance of the view, and the frequency of view. Scenic quality and sensitivity together are used as a basis for assessing impacts to visual resources.

The primary reference and method for defining visual resources is a standardized procedure developed by the BLM for identifying, evaluating, and classifying visual resources for land management purposes. The BLM Visual Resource Management (VRM) System is described in BLM (1986) and is outlined in Table 3.12-1. The VRM system inventories and evaluates both the scenic quality and the sensitivity of a landscape.

When inventoried for scenic quality, an area is first divided into subunits that appear homogeneous, generally in terms of landform and vegetation. Each area is then rated by seven key factors: (1) landform, (2) vegetation, (3) water, (4) color, (5) influence of adjacent scenery,

TABLE 3.12-1. VISUAL RESOURCES MANAGEMENT (VRM) SYSTEM PROCEDURE

STEP	DESCRIPTION
Landscape Character Inventory	The landscape character is considered to be a product of the form, line, color, and texture of the land and water forms, vegetation, and structures. The specific nature and combination of these conditions determine the variety, harmony, and distinctiveness of the landscape.
Scenic Quality Rating	The scenic quality part of the inventory documents the character of the landscape through consideration of the condition of seven rating criteria: landform, vegetation, water, color, man-made modifications, scarcity, and influence of adjacent scenery. From this assessment, an overall level of scenic quality is determined on a rating unit basis.
Visual Sensitivity	Visual sensitivity is an inventory component that is used to determine viewer exposure to the landscape.
Distance Zone	Distance zones are delineated from key viewing areas or routes. These zones establish a distance relationship between the viewer and the landscape.
Management Class	VRM classes are determined through the combination of the scenic quality, visual sensitivity, and distance zone inventory results. These classes serve as an index to the level of visual resource values and identify acceptable levels of visual modification. VRM classes are guidelines that are used for multiple-use land planning, land management, and environmental assessments.
Contrast Rating	The contrast rating process is used to determine whether a specific project proposal would be within the VRM class objectives for that area. It compares the degree of contrast or visual change between the form, line, color, and texture of the existing landform, vegetation, and structures and those proposed. This detail identifies, beforehand, specific sources of the anticipated landscape contrast and therefore provides a basis for effective and appropriate mitigation measures.

Source: BLM, 1986.

(6) scarcity, and (7) cultural modification. A standardized point system assigns great, some, or little importance to each factor. The values for each category are calculated and, according to total points, the landscape unit is assigned to one of the following Scenic Quality Classes:

- Class A areas: landscapes that combine the most outstanding characteristics of each rating factor.

- Class B areas: landscapes that exhibit a combination of some outstanding features and some that are fairly common to the physiographic region.

- Class C areas: landscapes that have features fairly common to the physiographic region.

Scenic quality ratings are then combined with a determination of viewer sensitivity to arrive at a VRM class. VRM classes range from I through IV and reflect the management priorities for preserving existing visual qualities, with VRM I having the highest priority for preservation (Table 3.12-2).

3.12.2 Gakona Site

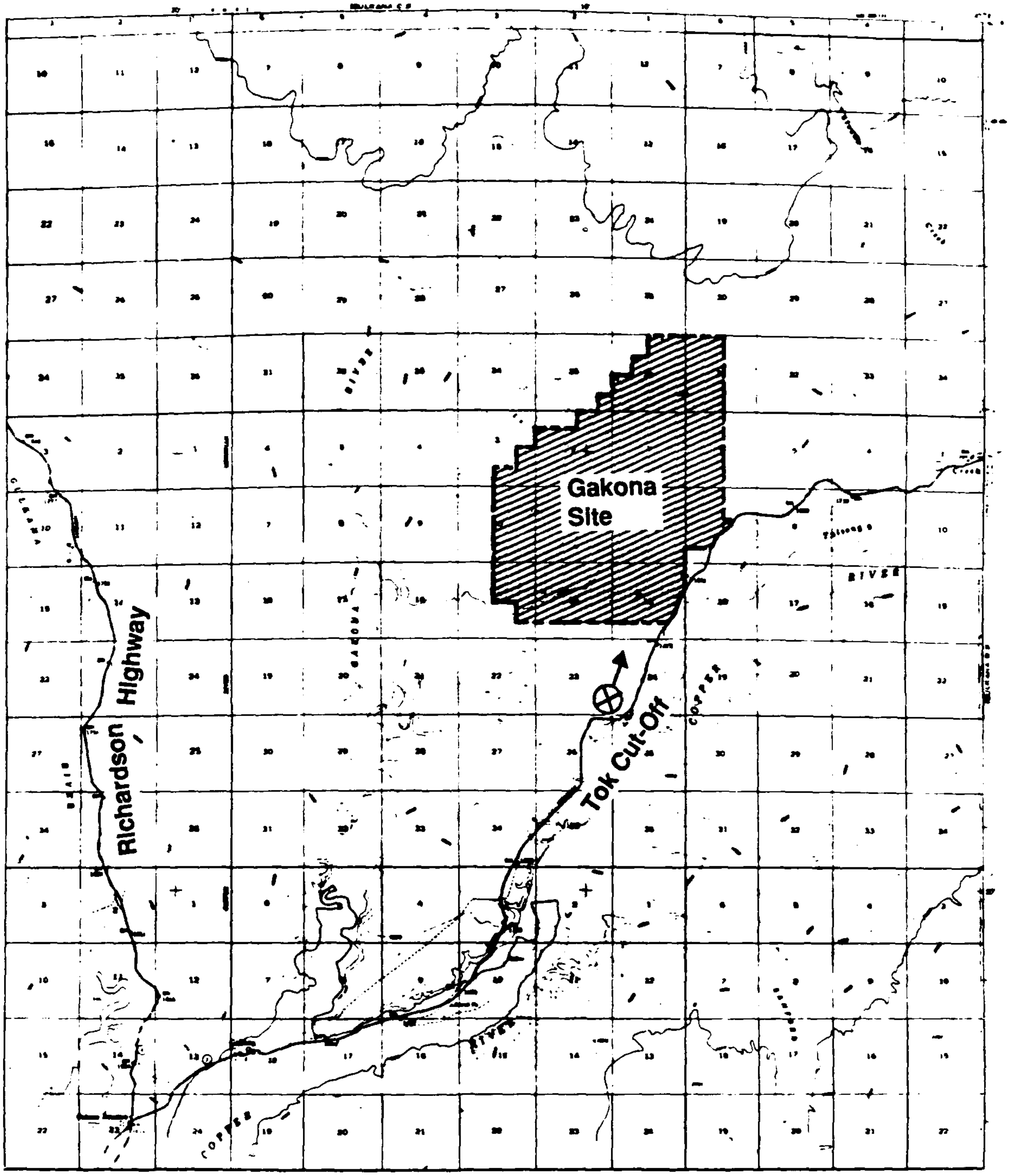
Visual Resource Characterization. Interim VRM ratings were assigned by the Air Force as part of the OTH-B environmental assessment, because no portion of the Gakona site had been officially assigned a VRM rating by the BLM (USAF, 1989a). These interim ratings are still valid and used in this document with the exception of the presently constructed OTH-B powerplant building and access road (Figure 3.2-1).

Figure 3.12-1 shows the location of the Key Observation Point (KOP) of the site as used in the OTH-B study (USAF, 1989a). This point remains the primary viewing location because it is assumed that the HAARP facility will occupy a similar area and is of similar enough physical

TABLE 3.12-2. VRM CLASSES FOR BLM LANDS

CLASS	DESCRIPTION
I	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes, however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.
II	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant features of the characteristic landscape.
III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
IV	The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

Source: BLM, 1986.



SOURCE: USGS Gulkana, Alaska 1977

— — — U.S. Air Force Property Boundary

LEGEND

KOP

FIGURE 3.12-1. KEY OBSERVATION POINT OF GAKONA SITE

nature that resulting visual differences from the OTH-B would be minimal. This viewing location is at milepost 9.2 of the Tok Cut-Off, approximately 1.5 miles from the assumed facility location. The potential sources of borrow material for the construction of the HAARP facility are the same as those evaluated under the OTH-B study. Since the mining operation and amount of borrow required would be similar to those previously evaluated, the VRM classes assigned to the potential borrow sites will be used here. In that study, borrow site P-1 received a Class II ranking, sites P-2, A-1, and A-5 received a Class III ranking, and site A-4 received a Class IV ranking (USAF, 1989a).

Based on an assessment from the KOP, the Gakona site was rated as B/C for scenic quality and low for viewer sensitivity. The overall VRM Class ranking was Class III/IV. From this viewing location, the existing Alascom microwave tower is visible 300 feet above the treetops and the existing powerplant building is slightly visible at the treetops, there is dense tree cover (20 to 30 foot tall spruce) in the middle ground, and there is a pond in the foreground. Travelling west, the powerplant building is slightly more visible from milepost 11.5 and fairly visible for a short period of time as one passes the access road at milepost 11.1 (Figure 3.12-2).

As viewed from above, at relatively low altitudes, the scenic quality rating was B and the viewer sensitivity was moderate to high. The overall VRM Class ranking was Class III/IV. From the air, the site is mostly uniform, dense tree cover spotted with meadows and ponds. The site access road, powerplant building and Alascom tower, operations building, and access road are visible.

A general characterization of visual features in the Gakona study area includes the strong dominant form of the Wrangell Mountains in the distant background to the southeast, and the broad meandering line and brownish color of the Copper River in the middle ground. Views of those features from the Richardson Highway and the Glenn Highway (same as Tok Cut-off) are limited by dense tree cover along the two major roadways in the area. Vegetation is predominantly black spruce (averaging 20-30 feet high) interspersed with willow and poplar,

FIGURE 3.12-2 PHOTOGRAPH OF EXISTING POWERPLANT BUILDING AND ACCESS ROAD AT GAKONA SITE

creating a uniform texture and color (dark green) in the foreground and middle ground of views from the road. Human modifications to the otherwise natural landscape include small buildings in the town of Gakona, the OTH-B white powerplant building and access road, the 300 foot red-and-white lattice Alascom communication tower, and several existing gravel borrow sites operated by the Alaska Department of Transportation.

3.12.3 Clear Site

Visual Resource Characterization. A general characterization of the visual features in the Clear area include the Alaska Mountain Range which starts with the rolling foothills only ten miles south of Clear AFS near the Bear Creek location. The grayish-blue silt laden Nenana River flows rather rapidly northward out of the Alaska Range past the Bear Creek location, but then broadens and slows as it meanders across the gently sloping lowlands toward its confluence with the Tanana River. Views along the Parks Highway and the Alaska Railroad of these features are relatively unobstructed through the mountains and foothills, but vegetation in the form of aspen, birch and spruce become more common in the lowlands area. This vegetation tends to restrict the visual field from both the highway and the railroad, and therefore lessens the visual sensitivity to anthropogenic facilities near Clear AFS. Human modifications to the otherwise natural landscape include small towns and clusters of structures along the highway and railway, and of course, the large BMEWS facility at Clear AFS. The level of man induced disturbance is fairly low at the Bear Creek location, with the exception of the railroad tracks, the highway, and the above surface power line that all run through the valley. Clear AFS property is a relatively developed area with numerous signs of man-made changes. This includes roads, trails, railroad tracks, cut-lines, antennas, communication towers, airstrips, gravel borrow areas, refuse disposal sites, and cleared areas for recreational and other purposes.

Interim VRM ratings were assigned for the Clear site as part of this study since no previous ratings existed for the areas of interest. As part of the VRM analysis, several Key Observation Points (KOPs) were selected for the Clear Site. The locations of the KOPs are shown on Figure 3.12-3 and 3.12-4. The selection of these locations were based on selecting the most critical

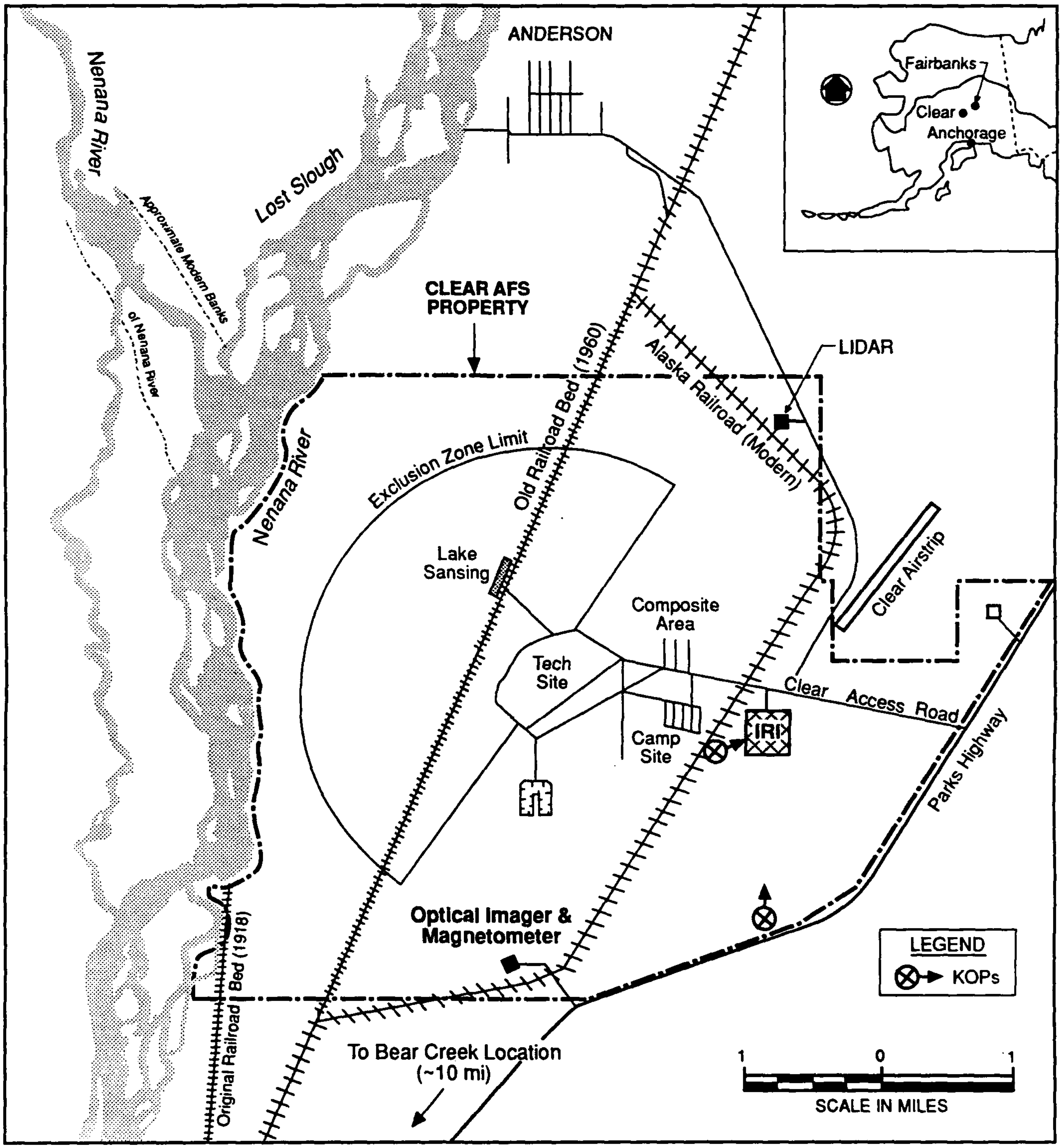


FIGURE 3.12-3. CLEAR AFS PROPERTY KEY OBSERVATION POINTS

2817/dl.

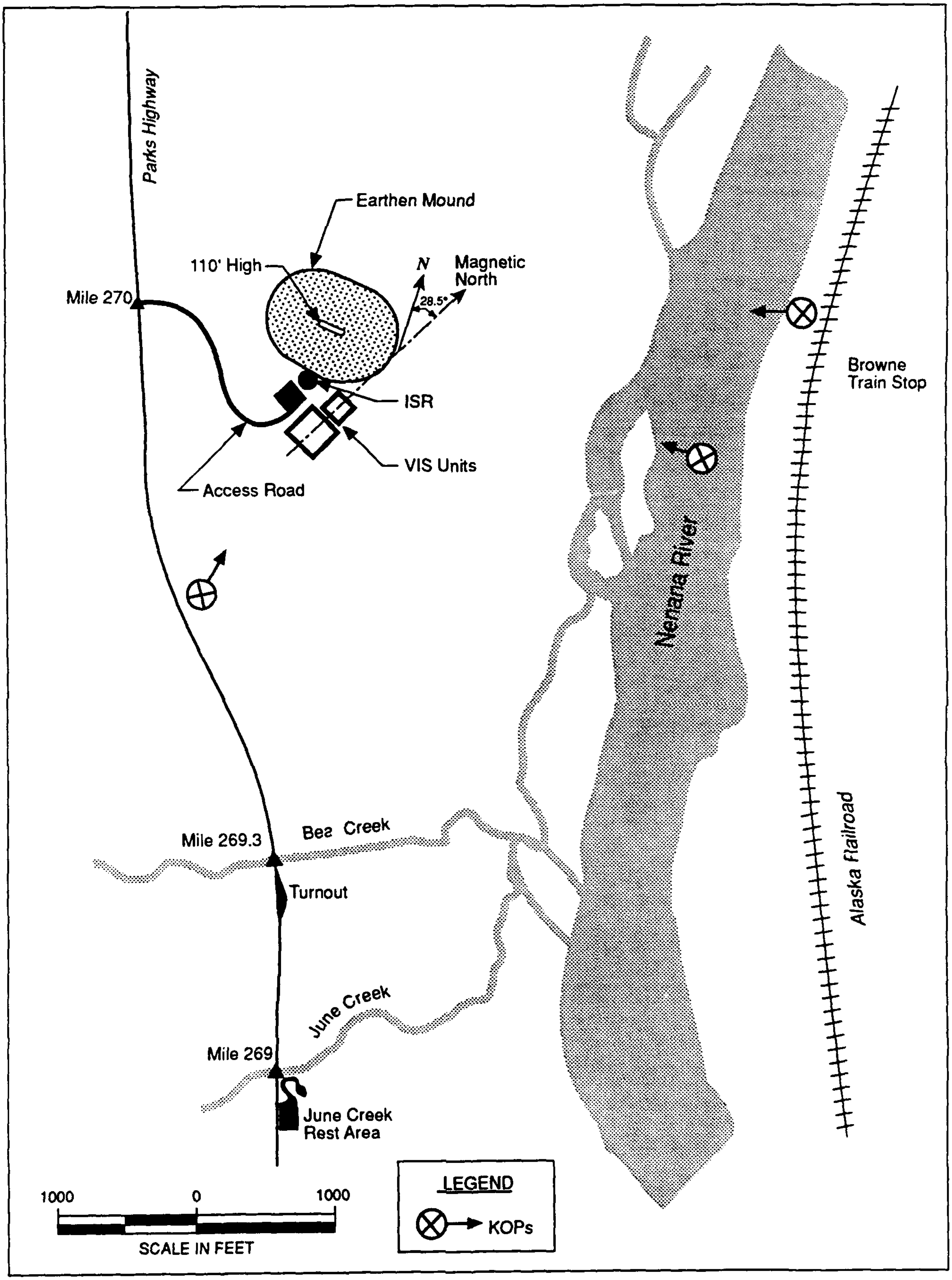


FIGURE 3.12-4. CLEAR SITE KEY OBSERVATION POINTS AT BEAR CREEK LOCATION

view points for each of the areas from commonly traveled routes such as the Parks Highway, the Alaska railroad tracks, and the Nenana River.

For the Clear AFS property location, two KOPs were used for the IRI site including mile 284 Parks Highway, and mile 391 of the Alaska Railroad trackage. No KOP's were selected for the magnetometer and optics equipment or the LIDAR diagnostics, as this equipment is small and is seen to be aesthetically insignificant compared to the IRI towers.

For the Bear Creek location, three KOPs were selected, mile 269.5 of the Parks Highway (Figure 3.12-5), mile 381 of the Alaska Railroad (formerly called the Browne train-stop), and from a point on the river near the confluence of Bear Creek and the Nenana River. Refer to Figure 3.12-4 for the location of the KOPs relative to the ISR siting.

Based on an assessment from the KOPs, the Clear AFS property location is given a scenic quality rating of C and a viewer sensitivity rating which is low to moderate. The overall interim visual resource management (VRM) rating is considered to be Class IV.

Based on an assessment of the Bear Creek location from the selected KOPs, the site is given a scenic quality rating of B and a viewer sensitivity rating which is moderate to high. The overall VRM is considered to be Class II. This interim rating is supported by a visual resource inventory of the Nenana River Corridor which was performed by the National Park Service as part of 1991 recreational study of the area (ADNR, 1991b).

FIGURE 3.12-5 PHOTOGRAPH TAKEN FROM HIGHWAY KEY OBSERVATION POINT AT BEAR CREEK LOCATION

3.13 BIOEFFECTS OF RADIO FREQUENCY RADIATION (RFR)

RFR would be generated during the operation of the HAARP facility at either the Gakona or Clear site. RFR (also referred to as radio waves) is electromagnetic waves at frequencies between approximately 3 kilohertz (kHz) and 300 gigahertz (GHz). People in these areas are continually exposed to RFR from many currently existing natural and man-made sources. The existing radio frequency radiation environment for the Gakona and Clear sites is similar. Hence this section focuses on the overall bioeffects of RFR. To support this section, the government commissioned a special study by experts in the field of RFR bioeffects to review the current information available on the topic. The conclusions of this evaluation were provided in 3 reports to the Air Force (AUSA, 1992a,b,c) and are incorporated into this document by reference.

3.13.1 RFR

The news media often do not distinguish between RFR and ionizing radiation. This sometimes raises concerns, with no scientific basis, that RFR can give rise to the hazardous effects known to be caused by ionizing radiation.

Ionizing radiation, such as ultraviolet light, x-rays and gamma rays and emissions from radioactive materials, have frequencies millions and trillions of times higher than those of RFR. A "quantum" of any of those radiations has enough intrinsic energy to ionize (eject an electron from) an atom or molecule. The ejection of an electron from a molecule leaves the molecule positively charged, thereby greatly altering its own properties and enhancing its interactions with its neighboring molecules. The resulting effects can be cumulative and irreversible, and thus can profoundly effect the health of living organisms. For this reason, devices such as film badges, are commonly used for monitoring cumulative exposure over time (total doses) of ionizing radiation.

In contrast to ionizing radiation, quanta of nonionizing radiation (such as RFR) have intrinsic energies far too small to ionize molecules within a body because their frequencies are vastly

lower. Rather than evoking changes in molecules (as in ionizing radiation), nonionizing radiation simply agitates molecules making them vibrate and rotate faster (note that all molecules naturally vibrate and rotate), the equivalent of adding heat to the body. The additional molecular agitation produced by the RFR ceases when exposure to RFR ends. The heat induced in an warm-blooded animal by exposure to RFR at relatively low incident power densities normally can be compensated for its thermoregulatory capabilities. However, depending on the species, the heat produced at relatively high intensities may exceed the thermoregulatory capabilities of the animal, so compensation for such effects may be inadequate. Thus, exposure at high intensities could cause gross heating and subsequent thermal distress or irreversible thermal damage. Some researchers have reported bioeffects at RFR levels below those giving rise to gross heating. However, such reports are not universally accepted by the large majority of the research community.

Examples of commonly used RFR-generating devices include:

- Public TV
- Radio broadcasting stations
- Citizen-band radios
- Ham radio transmitters
- Cellular telephones

The federal government regulates the use of these devices primarily through the Federal Communications Commission (FCC). These agencies restrict the operation of RFR devices to specific frequency bands and emission power levels.

3.13.2 RFR Exposure Safety Standards

Terms such as "safety standards" and "exposure standards" generally refer to, and are frequently used interchangeably with, specifications or guidelines on maximum exposure levels to RFR by the general public or workers. Such levels are usually expressed as maximum permissible

exposure (MPE) limits, threshold limit values (TLVs), or maximum power densities or field intensities in specific frequency ranges for stated exposure durations.

Several groups, listed below, have established standards and guidelines for human exposure to RFR.

- American National Standards Institute (ANSI)
- American Conference of Governmental Industrial Hygienists
- Air Force Occupational Safety and Health
- International Non-Ionizing Radiation Committee of the International Radiation Protection Association
- Institute of Electrical and Electronics Engineers (IEEE)

These standards and guidelines were based on maximum values of "specific absorption rate" (SAR) that were found to be not harmful in experimental animal studies. SAR is the rate at which RFR energy is absorbed in any small region of an animal's body. A conservative additional safety margin (either 10 or 50 times) is factored into the standard.

In 1988, the function of ANSI subcommittee C95.VI were transferred to Subcommittee IV of Standards Coordinating Committee (SCC) 28, a new body under jurisdiction of the IEEE. In 1991, SCC issued new guidelines covering the frequency range from 3 kHz to 300 GHz. Unlike previous guidelines, the SCC guidelines separately specified the maximum allowable RFR exposure in "uncontrolled environments" (accessible by the general population) and "controlled environments" (such as occupational exposure). Among the differences between the 1982 ANSI and the 1991 SCC standards are the newer limits for "uncontrolled environments" have a safety reduction factor of 50 instead of 10, but are averaged over any 30-minute period instead of 6 minutes. The corresponding limits for "controlled environments" remained at a safety reduction factor of 10 averaged over 6 minutes. The most up-to-date standard is the IEEE C95.1 - 1991 standard (IEEE, 1991). The maximum permissible exposures (MPEs) at the HAARP IRI frequencies according to the IEEE C95.1 - 1991 are listed in Table 3.13-1.

TABLE 3.13-1. MAXIMUM PERMISSIBLE EXPOSURES FOR THE HAARP IRI FREQUENCY RANGE ACCORDING TO THE IEEE C95.1 -1991 STANDARDS.

ENVIRONMENT TYPE	FIELD	FREQUENCY		AVERAGING TIME
		3 MHz	10 MHz	
Uncontrolled Environment	Electric (E)	275 V/m	82 V/m	30 minutes
	Magnetic (H)	5.4 A/m	1.6 A/m	6 minutes
Controlled Environment	Electric (E)	614 V/m	184 V/m	6 minutes
	Magnetic (H)	5.4 A/m	1.6 A/m	6 minutes

The uncontrolled environment figures are appropriate for areas accessible to the general population. Controlled environment values are for occupational exposure guidelines.

3.13.3 Biological Effects of RFR

The frequencies HAARP would use fall within the 3 kHz to 300 GHz range covered by the exposure standards. Therefore, the potential biological effects of RFR discussed below will be those solely due to nonionizing radiation. Findings of various peer reviewed, scientific, epidemiological studies on the effects of RFR, including those of studies with human volunteers, were analyzed. The results of such epidemiologic studies are regarded as indirect or inferential because the RFR-exposure levels and their durations most often are not known with any degree of accuracy (AUSA, 1992a). Although some results were conflicting, the preponderance of the studies found that chronic exposure to RFR at levels within the IEEE C95.1 - 1991 standard exposure guidelines did not result in demonstratable, detrimental health effects (AUSA, 1992a). Therefore, taken collectively, the epidemiologic studies indicate that chronic exposure to RFR at levels within any of the U.S. exposure guidelines is not hazardous to humans.

It is necessary to distinguish between an effect and a hazard. For example, a person's metabolism can be increased harmlessly by mild exercise. Analogously, an effect produced at

RFR intensities that yield heat that can be easily accommodated within the thermoregulatory capabilities of an individual may not necessarily be harmful. Also, the effects produced thereby are generally reversible. However, the thermoregulatory capabilities of any given species may be exceeded at high RFR intensities, so compensation for such effects may be inadequate. Thus exposure at such intensities can cause thermal distress or even irreversible thermal damage and represent an hazard (Ausa, 1992b).

Considerable research has been conducted on the potential for biological effects from RFR. Most of the knowledge concerning the biological effects of RFR has been obtained through experiments in which various mammals (including human volunteers) and non-mammals (such as birds, insects and bacteria or other microorganisms) were exposed to RFR. The subjects were closely monitored and tested for various biological effects. In addition to whole organisms, tissues, blood, single cells, cultures of cells, and subcellular components also have been studied.

The comprehensive independent critical review (AUSA, 1992a) on biological effects of RFR concluded that there is no credible scientific evidence that exposures to levels below the maximum levels specified in IEEE exposure standard (IEEE, 1991) will in any way be hazardous to health.

3.14 ELECTROMAGNETIC ENVIRONMENT AND RADIO FREQUENCY INTERFERENCE

This section describes the existing electromagnetic environment and sources of noise and interference present around the earth, at the Gakona and Clear sites. In addition to electromagnetic receiving systems that could experience interference, other systems are discussed that are not intended to receive radio transmissions but may be affected by HAARP transmissions. The information presented in the following section was largely obtained from MITRE (1992b,c,d,e) and a previous description of the electromagnetic environment in the Gakona site area that was prepared by the OTH-B program (USAF, 1986a).

The electromagnetic environment is comprised of a large range or spectrum of man-made and natural sources of wave energy. Wave energy is a renewable resource having variable dimensions of amplitude, time, frequency, and space. For humans to make use of some portion of the electromagnetic environment for communication, radio-location, radio-navigation, or other such purposes, the power of the transmitted signal must exceed the power of "background" noise and interference *in that portion of the electromagnetic spectrum* at the receiving station (USAF, 1987). Background noise and interference to radio receiving systems can be caused by man made and natural sources. Interference generally occurs when two or more radio waves are transmitted, by humans or natural processes, using the same frequency. A receiver could experience interference because of the masking of a desired weaker signal by a more powerful transmission at the same frequency (USAF, 1987).

3.14.1 Global Electromagnetic Environment

Man-made contributions. Man-made contributions to the existing global electromagnetic environment include both intentional transmitted wave signals and unintentional contributions, noise or interference, which are a result of electronic devices and powerful transmitted wave signals.

Intentional man-made contributions to the existing electromagnetic environment include a wide array of wave signals from sources such as various international and local broadcast radio and TV stations, satellite communications, local and long distance amateur (HAM) and Citizens' Band (CB) operators, air navigation aids, radars, and passing aircraft. High altitude ionospheric reflection of some radio signals, known as the sky wave transmission, allows transmissions from one point on the earth's surface to potentially any other location on the earth's surface.

Unintentional man-made contributions to the electromagnetic environment are referred to as man-made electronic noise or interference. Noise is typically radiated by sources such as power lines, fluorescent lights, household lighting dimmer switches, household appliance motors, computers and hand-held calculators. A major contributor is the automobile ignition system, which radiates a pulse of energy over all of the communication bands with each spark-plug firing. Since noise sources are associated with human activity, noise generally increases with increasing population. Thus, the noise environment is much greater in an urban region as compared to a rural region (USAF, 1987). As mentioned above, interference can occur as a result of the masking of a weaker signal by a more powerful one. Often the masking signal is an unintended signal (harmonic or spurious) that is produced as a result of the intended transmission of another signal at a different frequency. Since harmonic and spurious signals are inherently weaker than the intended signal and lose strength with distance from a transmitter they are usually not a significant source of interference.

Natural Contributors. Thunderstorms, solar flares, auroras, and galactic noise are the most important contributors to the electromagnetic environment. Galactic noise originates from the sun and stars and does not propagate from other areas of the earth by sky wave. Thunderstorms generate waves at frequencies up to about 20 MHz. Lightening strikes from storm centers located half way around the globe from a given location can cause interference (static) to radio reception. Each lightning stroke acts as a power transmitter covering a wide frequency band and produces a "signal" that reflects off the ionosphere to regions thousands of miles away (USAF, 1987).

3.14.2 Electromagnetic Environment at the Gakona Site

The existing electromagnetic environment at the Gakona site is affected by all of the above man-made and natural contributions discussed above. Galactic noise from natural features of the electromagnetic environment is expected to be the predominant existing contributor at the Gakona site since the site is in a rural area where man-made contributions are expected to be minimal (USAF, 1987). The primary man-made contributors of noise at the Gakona site are probably microwave transmissions from the Alascom tower located just north of the site and automobile ignition systems of vehicles that are driven past the site on the Tok Cut-Off highway (USAF, 1987). Other sources of man-made noise are not expected to contribute significantly to the existing electromagnetic environment in the region including the Gakona site.

3.14.3 Electromagnetic Environment at the Clear Site

The Clear site is compared to the Gakona site in a qualitative manner to obtain a relative understanding of the existing electromagnetic environment at the Clear site. The electromagnetic environment at the Clear site is affected by all of the man-made and natural contributions discussed above but is mostly impacted by the BMEWS on Clear AFS. The existing man-made noise and interference on the Clear AFS property is probably higher than surrounding areas and at the Gakona site because of the BMEWS radar transmissions and other base operations involving communications and surveillance. The existing man-made noise levels at the Bear Creek location are most likely low and more similar to those of the Gakona site due to its location about 15 miles south of the Clear AFS property. Noise from natural features of the electromagnetic environment is expected to be minimal compared to man made sources on the Clear AFS property. Natural contributions to the electromagnetic environment at the Bear Creek location are expected to be proportionally greater than those at the Clear AFS property. However, man-made noise is still expected to be the predominant feature characterizing the electromagnetic environment at the Bear Creek location as well.

3.14.4 Potentially Affected Systems

The proposed HAARP facility at either the Gakona or Clear sites could potentially increase background noise and interference to local and global receiving systems due to the power of the proposed IRI and the frequency range in which it would operate. The HAARP facility at the Gakona and Clear sites would consist of the three primary transmitters: the IRI, the vertical incidence sounder (VIS), and the ISR. The IRI and the VIS will transmit in the High Frequency (HF), 3 to 30 megahertz, range of the spectrum (Sams, 1975). The HAARP IRI transmitter would emit a signal in the HF range of the spectrum between roughly 2.8 and 10 MHz and the VIS would operate in the 1.0- to 15.0-MHz range. The ISR would transmit in the 440 to 450 MHz portion of the ultra high frequency band.

The most common types of systems that operate in the IRI and VIS 1- to 15-MHz range are high frequency communications that include Fixed, Broadcast, Mobile Communications, Amateur Radio (i.e., the Hams) and the Standard Frequencies systems. The Fixed Service is intended for point-to-point transfer of information between two cooperating fixed (i.e. not mobile) stations. Various types of modulation may be used, such as voice or teletype. The use of fixed service frequencies has been decreasing since the introduction of satellite systems, which have numerous advantages over HF systems (USAF, 1987).

The Broadcast Service uses transmitters located throughout the world which are operated by private industry, governments, religious organizations, and other groups. Those stations operating in the HF band are most often used for international or topical broadcasting. Hundreds of these stations, including Voice of America, Radio Moscow and Radio Havana,broadcast news, music, and other features generally intended for listeners beyond the country of origin (USAF, 1987).

Mobile Communication services are used for communication between and among land vehicles, ships, aircraft, and shore or base stations. The Hams are dedicated hobbyists who communicate with other Hams throughout the world using the HF, VHF and UHF bands. The Standard

Frequency bands support transmission of precise time and frequency information, as well as propagation predictions, solar and geophysical data, and similar information. They are operated by national government agencies and include radio stations WWV in Colorado, CHU in Ontario, and JJY near Tokyo (USAF, 1987).

EED's could be carried and used in the areas surrounding the HAARP facilities. Given that the government property boundary is not fenced and/or patrolled to prevent access to the site, EED's could be carried by the fences that surround the HAARP emitters. In addition, aircraft could fly over the HAARP emitters carrying EED'S.

A summary of potentially affected offsite systems and their closest proximity to the Gakona and Clear sites are identified in Table 3.14-1. In addition to reviewing documented information on existing systems, interviews were conducted with local users to confirm systems, frequencies and distances. Potentially affected receiver systems include those used for international broadcasts, communications, radionavigation, radar (BMEWS at Clear), citizen band radios, and others. Potentially affected systems that are not intended to receive radio transmissions include cardiac pacemakers, electro-explosive devices, and fuel handling systems.

3.14-1. POTENTIAL OFF-SITE SYSTEMS

RECEIVING SYSTEMS	FREQUENCY RANGE (MHz)	GAKONA SITE: Distance to closest receiver (miles)		CLEAR SITE: Distance to closest receiver (miles)	
		IRI	ISR & VIS	IRI at Clear AFS Property	ISR & VIS At Bear Creek Location
Cellular Telephone	870 - 890	.9	1.5	.9	.2
Satellite Television	5925 - 6875 12,500 - 12,750	6.9	6.9	.6	1.1
HF Communications	2.1 - 10 10 - 30	2.3	2.3	.6	1.1
Television Broadcast	60 - 216	2.3	2.3	.6	1.1
AM Radio Broadcast	0.535 - 1.7	2.3	2.3	.6	.2
FM Radio Broadcast	92.9 - 106.7	2.3	2.3	.6	.2
Avionics	GPS 1227, 1575 VHF Radio 118 - 137 UHF Radio 960 - 1125 VOR 115 - 116 ADF 0.25 - 0.40	Over-flight	Over-flight	Over-flight	Over-flight
Mobile VHF Radio	38 - 45 45 - 161	.9	1.7	.9	.2
Wildlife Trackers	30 - 45 45 - 222	.9	1.7	.9	.2
Citizen Band Radio	26.9 - 27.4	.9	1.7	.9	.2

continued.

TABLE 3.14-1 continued. POTENTIAL OFF-SITE SYSTEMS

RECEIVING SYSTEMS	FREQUENCY RANGE (MHz)	GAKONA SITE: Distance to closest receiver (miles)		CLEAR SITE: Distance to closest receiver (miles)	
		IRI	ISR & VIS	IRI at Clear AFS Property	ISR & VIS At Bear Creek Location
Hand Held Transceivers	VHF 118 - 174 UHF 403 - 470	.9	1.7	.9	.2
Radio Telephone	VHF 152-158 UHF 454-460	10.3	10.3	---	----
Pipeline Systems	Control 157, 162	11.5	11.5	69.1	74.8
	Maintenance VHF Communications 150-162	11.5	11.5	69.1	74.8
	Maintenance UHF Communications 450-460	33.4	33.4	69.1	74.8
Terrestrial Microwave	2127-2177 5945-6094	1.9	1.9	.5	12.7
Electro-Explosive Devices	Exposed In Metal Container	.9	1.7	.8	.2
Cardiac Pacemakers	Incident Pulsed Incident CW	.9	1.7	.9	.9

Source: MITRE, 1992D.
----: Information not available
Abbreviations Defined: HF = high frequency
AM = amplitude modulation
FM = frequency modulation
GPS = global positioning system
VHF = very high frequency
UHF = ultra high frequency
VOR = very high frequency omni-range
ADF = automatic direction finder

3.15 ATMOSPHERE

The atmosphere could be potentially affected in the same manner as the electromagnetic environment by transmissions at either the Gakona site or the Clear site. Hence the following section applies to both the Gakona and the Clear AFS property. The ionosphere and the ozone layer, at approximately 9-31 miles above the earth (Figure 3.15-1) shield the earth's surface from extreme ultraviolet (uv) light and x-rays. The following section discusses the ozone layer and the ionosphere.

3.15.1 Ozone Layer

Ozone is formed as a result of collisions between single oxygen atoms (O) and oxygen molecules composed of two oxygen atoms. The single oxygen atoms are formed as a result of the break up of oxygen molecules by solar radiation in the stratosphere and mesosphere (Brown and LeMay, 1977; Whitten and Prasad, 1985). Nitrogen oxides (NO_x), produced by both man and natural processes, and man-made chloro-fluorocarbons can destroy ozone molecules in the ozone layer. Processes and events which produce NO_x include solar flares, auroras, galactic cosmic rays, meteors, lightning and photochemical reactions in the upper atmosphere (MRC, 1992a). NO_x and chloro-fluorocarbons come into contact with the ozone layer primarily as a result of atmospheric circulation and diffusion. NO_x produced above the ozone layer can diffuse (gradual mixing of molecules) down into the ozone layer. The only loss of NO_x during downward transport occurs as a result of solar radiation and the recombination of N and NO_x (MRC, 1992a). In the polar atmosphere the likelihood of NO_x reaching the ozone layer increases during the winter because of a lack of solar radiation and prevailing (winter) downward circulation in the upper atmosphere (MRC, 1992a). Hence auroral activity (a significant source of polar NO_x) could have an appreciable effect on NO_x and ozone concentrations in the polar regions during the winter months (MRC, 1992a). During the summer months, in the polar latitudes, the NO_x depletion of ozone is minimized due to the destruction of NO_x, by solar radiation and reactions with nitrogen, as it is transported downward into the ozone layer.

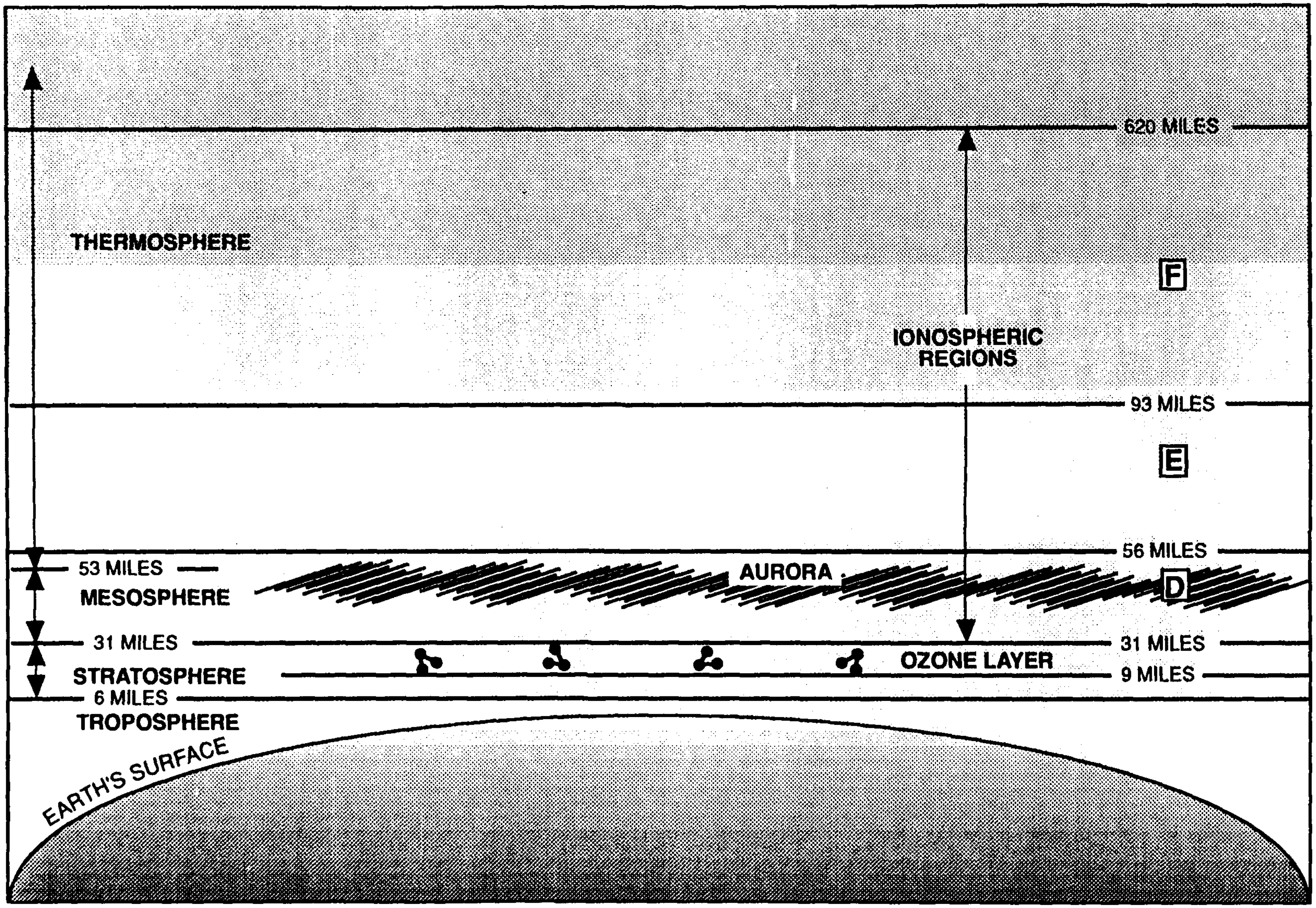


FIGURE 3.15-1. ATMOSPHERE

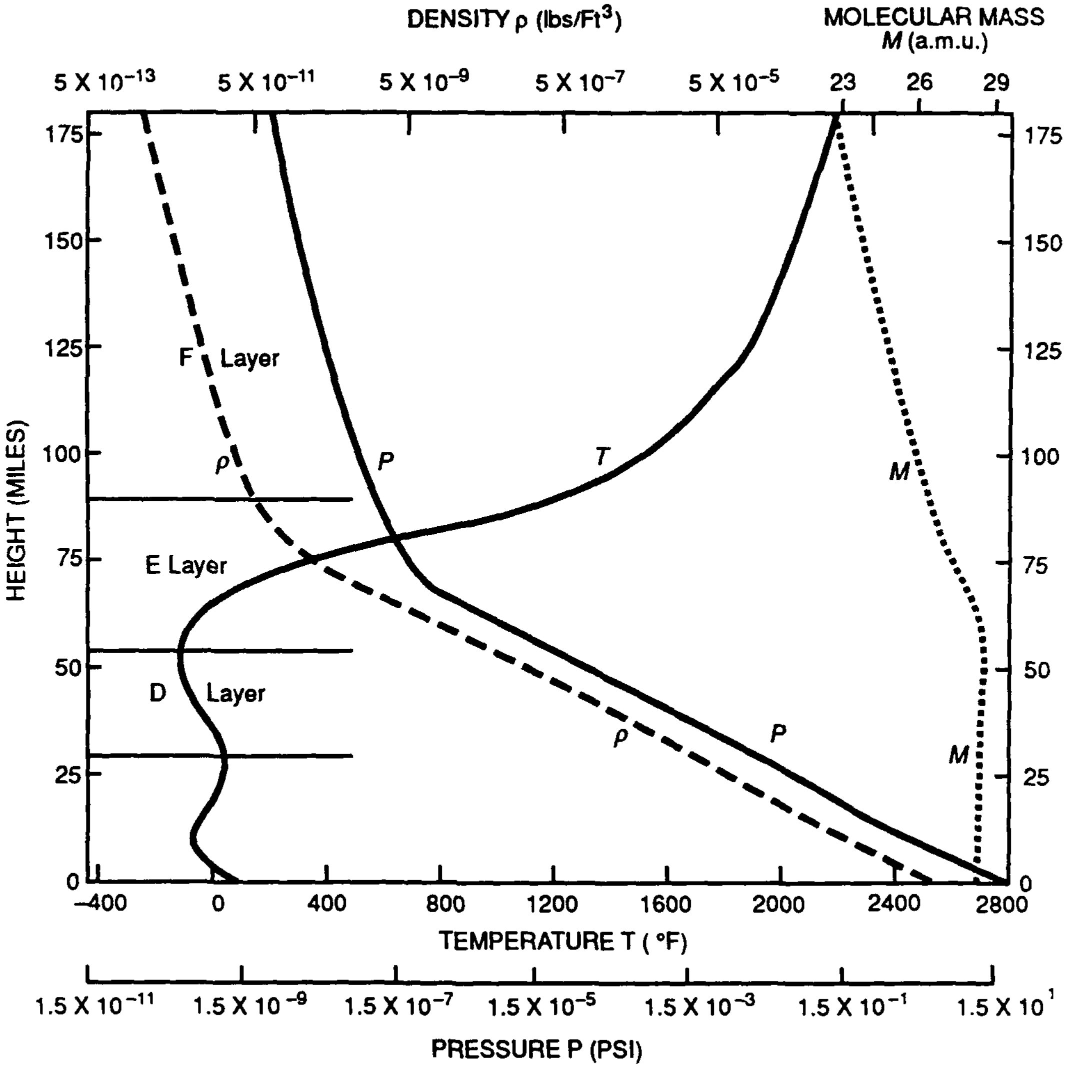
2817cc-3

3.15.2 Ionosphere

The ionosphere is formed in the sunlit portion of the earth's atmosphere as a result of ionization of the lower density upper atmosphere by solar radiation. The ionosphere serves as a buffer between the neutral atmosphere (gravity waves, tidal winds) and the ozone layer located immediately below the ionosphere (Figure 3.15-1) and the magnetosphere (energetic particles, electric fields, field-aligned currents, magnetic storms, etc.) located above it. The physical properties (Figure 3.15-2) and dynamics of the ionosphere vary widely over its full altitudinal extent because of complex interactions of electric and magnetic fields and gradients in temperature and density. Due to these variations the ionosphere was classified into three layers or ranges D, E, and F.

D Layer (Lowest Layer of the Ionosphere). The D layer of the ionosphere extends from approximately 31 miles to 56 miles (Figure 3.15-1). The D layer marks the beginning of the transition from the neutral lower atmosphere to the upper ionized atmosphere. The temperature in this region decreases with altitude to approximately -80 °F to -99 °F (Figure 3.15-2). The density of ionized particles increases with altitude (Figure 3.15-3). The ionized particles disappear completely after sunset where this layer overlies the Earth's mid to low latitude areas. The ionized particles disappear due to the absence of solar radiation, the source of ionization.

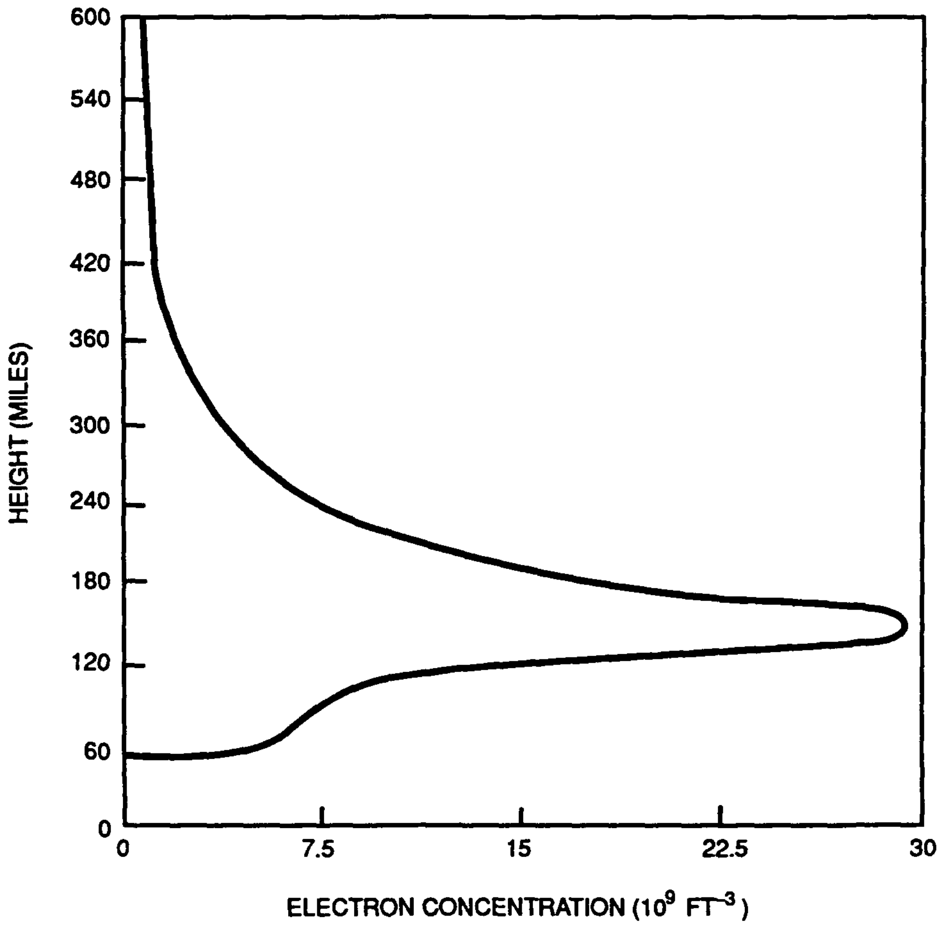
The aurora zone, within the D Layer (Figure 3.15-1), is where the northern lights or auroral borealis light displays are generated. The auroral borealis is a result of increased solar radiation (solar wind pressure) usually enhanced by a solar flare. The increased solar radiation causes the magnetosphere, the layer of the atmosphere immediately above the ionosphere, to accelerate ionized particles down into the aurora zone. The accelerated ionized particles cause the auroral borealis light displays.



SOURCE: Rishbeth and Garriot, 1969

M = Mass
T = Temperature
ρ = Density
P = Pressure
°F = Fahrenheit
a.m.u. = Atomic Mass Unit. The Measure of Atomic Mass, Defined as Equal to 1/12 the Mass of a Carbon Atom of Mass 12.

FIGURE 3.15-2. IONOSPHERIC PHYSICAL PROPERTIES



SOURCE: RATCLIFFE, 1972

FIGURE 3.15-3. DAYTIME IONOSPHERIC DENSITY

2817dl-13

E Layer (Middle Layer of the Ionosphere). The E layer extends from about 56 miles to 93 miles above the Earth's surface (Figure 3.15-1). Like the D layer, the E layer is also a transitional layer between the lower atmosphere and the upper ionized atmosphere. Average temperatures begin to increase rapidly, with altitude, from about - 100 °F to 1350 °F at the top of the layer. The high temperatures are a result of the absorbtion of large amounts of ultraviolet radiation. The ultraviolet radiation also causes the ionized particle density to increase rapidly with increasing altitude up to about 150 miles above the earth (Figure 3.15-3). As in the D layer, however, the ionized particles produced during the day in layer E largely disappear after sunset.

F Layer (Upper Layer of the Ionosphere). The F layer, the highest layer of the ionosphere, begins at about 93 miles and extends to 620 miles above the surface of the Earth (Figure 3.15-1). The highest density of ionized particles occurs between 155 miles and 186 miles within this layer (Figure 3.15-3). Unlike the D and E layers, a substantial amount of particles remain ionized throughout the night in the F layer.

3.16 THREATENED AND ENDANGERED SPECIES

There are no known threatened or endangered species at the Gakona site (USFWS, 1992h). One threatened species, arctic peregrine falcon, and one endangered species, American peregrine falcon, could occur at the Clear site (USFWS, 1992d). See Section 3.4 Birds for a full discussion of these threatened and endangered species at the Clear sites.

3.17 HAZARDOUS MATERIALS AND WASTES

Hazardous materials and wastes are substances that, because of their quantity, concentration, or physical, chemical or infectious characteristics, may present a danger to public health or the environment. In this document, the term hazardous waste or hazardous material will mean the substances defined as hazardous by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Solid Waste Disposal Act (SWDA), as amended by the Resource Conservation and Recovery Act (RCRA). Some of the more commonly used hazardous materials are pesticides, herbicides, fossil fuels, oils, solvents, and paints.

3.17.1 Gakona Site

Minor amounts of hazardous materials are presently used and generated at the Gakona site and are stored in the existing buildings. These materials are a result of the facilities maintenance and include fuel oil, motor oil, solvents, paint, glycol, hydraulic fluid and pesticides. The materials are presently used and stored in accordance with the appropriate state, federal and Air Force regulations.

3.17.2 Clear Site

There are no known hazardous materials or contamination at the locations proposed for the facilities at the Clear site. An Environmental Compliance Assessment and Management Program evaluation of Clear AFS was conducted in 1991 (FSI, 1991b). Clear AFS has an Oil and Hazardous Substance Contingency Plan which conforms to federal, state and DOD requirements. In addition, a storage area for hazardous materials conforms to all applicable standards. Clear AFS disposes of waste oil and asphalt by burning it in its power plant boiler with the approval of the ADEC. Clear AFS has a proposed program for upgrading underground fuel storage tanks where appropriate. The program is scheduled to begin during 1993. Clear AFS uses and maintains a permitted landfill on its property. An Installation Restoration Program for 2 contaminated sites at Clear AFS is nearly completed (FSI, 1991b).

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4.0 CONSEQUENCES

This section details the consequences of selecting one of the following alternatives: build the HAARP facilities at the Gakona site; build the HAARP facilities at the Clear site; or, take no action. There are varying degrees of environmental impacts associated with each of the alternatives within the subject topics presented below. To minimize these potential impacts associated with the construction and operation of the HAARP facility, the government would assure compliance with all state and federal laws and regulations, standards and permits. This includes, but is not limited to such laws as the Clean Water Act, and particularly Section 404 (Wetlands); the Clean Air Act; the National Historic Preservation Act (NHPA), and particularly the Section 106 Review Process; the Resource Conservation and Recovery Act (RCRA) regarding the treatment, storage, and disposal of hazardous wastes; and, the Endangered Species Act. For a more thorough discussion and listing of the federal and state permits to be obtained as part of the HAARP project, see Appendix B of this DEIS.

4.1 LAND AND MINERALS

4.1.1 Gakona Site

Potential adverse effects on land and minerals are related to development of borrow pits and soil diposal sites, land use, and permafrost degradation. With the implementation of sound planning, design, and construction practices, all such effects are expected to be minimal and limited during the construction period. No adverse effects are expected during facility operations.

Development of Borrow Sources and Spoil Disposal Sites. The construction of a stacked array design for the IRI and the associated equipment would require an estimated 160,000 cubic yards of gravel at the Gakona site.

Five potential borrow sources, all within 24 miles of the proposed research site, have been evaluated. The location of the borrow sites, identified as P1, P2, A1, A4, and A5, are shown

in Figure 2.3-4. Although potential borrow site alternatives have been identified, the construction contractor(s) would not be limited to those sources. Feasibility studies of each new potential source would involve additional subsurface investigations and facility design efforts, and detailed pit mining and rehabilitation plans prepared by the contractors. In the event that the contractor(s) proposes a borrow source not addressed within this DEIS, appropriate subsequent environmental analyses will be performed.

Impacts to land and minerals associated with the use of the potential borrow sites are as follows:

- degradation of roads by heavy trucks
- clearing of land associated with the construction of new access roads
- higher rates of erosion due to the removal of trees and ground cover during the excavation of the borrow material.
- possible stream or creek diversion

Based on the estimated large volumes of usable borrow at the five potential sites the impact on available resources is thought to be minimal. Gravel used for the development and maintenance of the HAARP facility is not expected to limit the quantities available for general road maintenance and other uses in the vicinity.

Land Use. New facilities would require about 51 acres of land. The entire site at Gakona, Alaska is owned by the U.S. Air Force. Existing structures on site include a partially constructed 21,000-square-foot, 73-foot-tall pre-engineered powerplant building and a gravel access road approximately one mile in length. Both of these currently unused facilities would be used by HAARP. A 300-foot-tall Alascom microwave tower is located just outside of the eastern site boundary. There are no existing rights-of-way and leases that would be significantly affected by construction at this site. Access to lands to the north of the Gakona site will be maintained. No change in the existing use of the Gakona site is anticipated.

Permafrost Degradation. Removing or disturbing vegetation over frost-susceptible soils could alter the thermal regime, which in turn could increase erosion, frost-heaving, and subsidence due to melting. Alteration of the thermal regime is certain to occur at the Gakona site. The site contains widespread permafrost conditions. Permafrost temperatures are very warm, ranging from about 31 to 32 degrees F, making the site sensitive to small changes in the thermal regime (USACOE, 1988).

Mitigation. Post-construction impacts would be mitigated by reclamation through recontouring and revegetation of disturbed areas. Personnel at the University of Alaska Plant Materials Center in Palmer, Alaska, recognized experts in Alaskan revegetation, would be contacted for site-specific information on revegetation techniques.

Design and construction techniques would be employed to minimize disturbance to the permafrost. The placement of piles for the support of antennae towers would, schedule permitting, take place during the winter months when the surface is frozen. Roads constructed of ice and compacted snow could be constructed, if necessary and practical, to ensure that the equipment used for pile installation can be supported by the frozen ground and does not disturb the permafrost. As appropriate, gravel roads would be constructed with geotechnical stabilization fabric and closed-cell insulation overlying the permafrost. The geotechnical fabric and insulation retards heat transfer from the gravel surface to the permafrost and therefore provides for long term stabilization of the permafrost in the vicinity of the roads. Use of insulation could also be used to limit the amount of sand and gravel required to construct at the Gakona site.

4.1.2 Clear Site

Below is a discussion of the consequences of selecting the Clear site, and possible mitigation efforts that could be implemented. In addition to the obvious impacts and mitigation measures at the Clear site itself, consideration must also be given to the impacts and mitigation associated with the Gakona site reclamation effort. That is, one of the consequences of selecting the Clear

site is the near-term reclamation effort that must be implemented at the Gakona site. A discussion of the reclamation effort and its consequences and mitigation as it relates to land and minerals is included under Section 4.1.3 No Action Alternative, Gakona site.

Development of Borrow Sources and Spoil Disposal Sites. The amount of gravel necessary for construction of the HAARP facility at the Clear Site is estimated to be 31,000 cubic yards, of which 16,000 would be for roads at the Clear AFS property, and 15,000 would be for the Bear Creek location site development. This relatively small quantity of gravel is a reflection of the good quality substrate and the low ice content of the permafrost.

There are numerous borrow sites at Clear AFS that have been used for past and current construction projects (Figure 2.3-7). It is anticipated that one of these existing sources could be used to supply gravel for HAARP construction. In the event that the construction contractor proposes a borrow source which does not already exist at Clear AFS, the appropriate subsequent environmental analysis will be performed.

Impacts to land and minerals associated with the mining of gravel at the established and active borrow areas are:

- degradation of roads by heavy haul trucks
- destruction of trees and ground cover when excavating borrow
- general increased road traffic

Based on the small quantity of gravel required to construct the HAARP facility at Clear, the impact on the available resource is thought to be minimal.

Construction practices at Clear AFS and the surrounding area include the stripping away of a top vegetative mat and silty loess which ranges from 1 to 6 feet thick, exposing the higher quality gravels and sands which lie below. The construction of the IRI and the other equipment at the Clear AFS property would employ this technique as well. This stripped off material could

encompass a rather large volume, depending on its thickness in the region in question. This material would be hauled by heavy truck to an on-site disposal location or to an abandoned gravel excavation site. This action would possibly have a net positive impact from an aesthetic and animal habitat perspective by facilitating plant re-growth.

At the Bear Creek location, the top layer of material that is stripped away would be used to construct an earthen berm in front of the ISR dish, between it and the BMEWS antennas at Clear. This earthen berm is intended to afford electromagnetic protection from the BMEWS equipment. Estimates suggest that the amount of material generated from stripping at Bear Creek would be equal to the amount required to construct the mound.

Land Use. Construction of the HAARP facility at the Clear site would include the occupation of about 78 acres of cleared land, with 41 at the Clear AFS property, and 36 at the Bear Creek location. The 41 acres at the site proper is located exclusively on Air Force property, and no change in land ownership would be required. Current siting of the major scientific equipment involves no known physical conflicts with existing station activities. The Clear airstrip is located to the north of the IRI siting, but according to Federal Aviation Administration requirements for airport design and layout, there are no physical conflicts.

The land at the Bear Creek location is owned by the State of Alaska. The land that the equipment would be situated on is planned to be used for settlement or other developmental-type endeavors. Several homesteads have been filed in the Bear Creek area. If the homesteading requirements are met by the individuals, then some of the land may be deeded over to private ownership. Land within several hundred yards of the Bear Creek location is part of the Nenana River Corridor and is considered prime recreation land and has been recommended for designation as a State Recreation River as part of the Tanana Basin Area Plan for State Lands (ADNR, 1991a,b).

There are no known dwellings in the immediate area of the Bear Creek location footprint, although houses are present within one mile of the proposed location of the ISR and VIS. Man-

made disturbances in the immediate area are limited to surveying stakes and ribbons, and temporary benchmarks (M&E/H&N, 1992a).

Permafrost Degradation. Permafrost is discontinuously present at the Clear AFS property and the Bear Creek location. The ice-poor nature of this non-frost susceptible soil makes the issue of thermal disturbance inconsequential.

Mitigation. Post-construction mitigative measures would include a revegetation program. Personnel at the University of Alaska Plant Materials Center should be consulted regarding the revegetation effort.

The construction scheduling could influence the degree of impact upon the area. In a general sense, impacts would, when feasible, be reduced by conducting major construction in the winter when the ground is frozen and snow covered, and less susceptible to damage. Other mitigation measures include using geotextile fabrics to stabilize the soil matrix.

The mantle material stripped from the ground to expose the underlying gravel could be used as a fill material for areas that have been previously mined for gravel. The relocation of this mantle material would be confined to a limited area rather than being spread out over existing vegetation in the area of construction.

Siting of the ISR and VIS units at the Bear Creek location would be conducted such that both direct and indirect impact to private individuals is minimized. Facilities would be located, when possible, to minimize visual contact between private and potentially private tracts of land and the HAARP facilities. Impacts to the recreational corridor would be mitigated by utilizing proper visual architecture techniques to minimize visual contact with the river.

4.1.3 No Action Alternative

Gakona Site. The impact of selecting the no action alternative at Gakona would result in the near-term reclamation of the Gakona OTH-B site as outlined in Section 2.4. Reclamation of the site would include the removal of culverts (replaced with ditches extending across the road), the scarifying of the gravel road to induce revegetation, and the demolition and complete removal of the 21,000 square foot powerplant building and all associated equipment and materials.

The no action alternative would require no additional gravel at the site. In fact, it could be necessary to remove approximately 29,000 cubic yards of gravel.

Upon completion of the reclamation effort, the Air Force owned land at the Gakona site would be turned over to General Services Administration (GSA) who would oversee the land disposal process if no other DOD use is planned. The land would then be sold or transferred in accordance with applicable regulations.

Clear Site. There would be no impact on land and minerals associated with the no action alternative at the Clear Site.

4.2 VEGETATION AND WETLANDS

Project activities would affect vegetation and wetlands by the removal, alteration or disruption of the existing vegetation during construction. General types of potential impacts to the vegetation include (1) placement of gravel fill, which would completely destroy the existing vegetation; (2) clearing of standing trees, leaving the understory mostly intact; (3) disruption of buffer areas around the facilities during construction; and (4) mining of borrow. For descriptive purposes, filled areas were categorized as: (1) roads providing access to specific facilities, (2) roads allowing access to individual antenna elements within the IRI facility, and (3) gravel pads for buildings and miscellaneous structures.

4.2.1 Gakona Site

Vegetation. The project would have no significant impact to vegetation. Loss of conifer forests would not detract from their relative regional abundance, because they are so common (M&E/H&N, 1989b). These conifer forests, comprised of closed, open, or woodland stands, can be considered the least sensitive and most expendable of the existing cover types because they are abundant and are of limited value as wildlife habitat and timber (M&E/H&N, 1989b). Shrub and herbaceous cover types are more valuable to wildlife than conifer forest and are also less common on the site (see Section 3.2). However, the unavoidable loss of relatively small acreage of herbaceous and shrub cover types would not noticeably reduce their regional abundance or alter ecosystem diversity.

The IRI facility would affect a total of approximately 37 acres, including 32 acres of woodland conifer forest and 5 acres of open conifer forest (Table 4.2-1). Of this acreage, approximately 27 acres would be filled. The remaining 10 acres would include areas that would be cleared, piled with slash, trampled or similarly disturbed.

TABLE 4.2-1. AREAS OF VEGETATION COVER TYPES (IN ACRES) AFFECTED BY THE HAARP FACILITIES AT THE GAKONA SITE

Cover Types[1]	IRI	Diagnostics and Roads						TOTAL
		ISR	VIS	Optics and Magnet-ometer	LIDAR	Access Roads	TOTAL	
Open Conifer	5	1	2	<1	0	7	11	16
Woodland Conifer	32	0	0	0	0	0	0	32
Closed Low Shrub	0	0	0	0	<1	<1	<1	<1
Open Low Shrub	0	0	<1	0	0	<1	1	1
Wet Herbaceous	0	0	0	<1	<1	0	1	1
TOTAL	37[2]	1	3	1	<1	8	13[2]	51[2]

[1] Cover types follow Viereck et al. (1986).

[2] Since the values have all been rounded to the nearest whole number for presentation purposes but the actual fractions were used in sums, the totals of the IRI, diagnostics and roads and overall total do not sum.

The diagnostics and access roads would impact approximately 13 acres (Table 4.2-1). Open conifer forest (11 acres) would be the most affected followed by about equal amounts of closed low shrub, open low shrub, and wet herbaceous vegetation groups. Most of the impacted area would be filled and would be associated with the construction of approximately 11,450 feet of access road (Table 4.2-1).

Most of the proposed borrow areas are dominated by closed deciduous, closed conifer, or closed mixed forests (see Section 3.2). Borrow areas A-1 and A-5 have more shrub and herbaceous cover types than do the other areas. Impacts would result from clearing, complete removal of vegetation, and excavation. Exact acreages of impacts would be dependent upon the borrow source, site geological characteristics, and mining techniques.

Wetlands. The loss of 18 acres of wetlands from all facilities would not constitute significant impacts to wetlands in the region (Table 4.2-2). The vast majority of these wetlands would be

TABLE 4.2-2. AREAS OF WETLAND COVER TYPES (IN ACRES) IMPACTED BY THE HAARP FACILITIES AT THE GAKONA SITE

Cover Type[1]	IRI	Diagnostics and Roads						TOTAL
		ISR	VIS	Optics and Magnet-ometer	LIDAR	Access Roads	TOTAL	
PALUSTRINE FORESTED Wet Open Conifer	6	1	2	<1	<1	7	11	17
PALUSTRINE EMERGENT Wet Herbaceous	0	0	0	<1	<1	0	1	1
TOTAL	6	1	2	1	<1	7	12	18

[1] Cover types (capitalized) follow Cowardin et al. (1979) and (tabbed) Viereck et al. (1986).

palustrine forested wetlands (17 acres) which are common in the area. The IRI would affect about 6 acres of wetland. Due to its design calling for roads, rather than a complete pad, only about 4 acres of the wetlands affected by the IRI would be filled. The remaining 2 acres would be cleared, piled with slash or otherwise disturbed.

The majority of the acreage for the roads and diagnostics represents filled areas. Wetland impacts from locating the on-site diagnostics and their access roads would impact approximately 12 acres of wetlands, including 11 acres of palustrine forested wetlands and 1 acre of palustrine emergent wetlands (Table 4.2-2). Nearly all this acreage would also be filled and would be associated with the approximately 11,450 feet of access roads.

Proposed borrow areas P-1, A-1 and A-5 (21 percent, 14 percent, 22 percent respectively) contain the most wetlands. These wetlands are largely riverine fresh water, riverine emergent (dominated by herbaceous cover type) and riverine scrub-shrub (dominated by open low shrub). Areas P-2 and A-4 are essentially devoid of wetlands. These wetlands could be impacted by the

removal of vegetation, excavation, or fill. The exact nature and extent of impacts will depend upon the source selected and the mining techniques used.

Mitigation. Although there would be no significant impact from the project to vegetation or wetlands, there are a number of mitigative steps that have already been taken in the siting process of facilities and there are additional measures that could be undertaken to further minimize impacts or to offset impacts. These measures largely involve the avoidance of important habitats and wetlands and minimization of impacts when avoidance would not be possible.

Vegetation. Loss of the ecologically more valuable and less common herbaceous and shrub cover types was avoided during facility siting at the expense of the ubiquitous open/woodland conifer forested cover types (see Section 3.2). The Gakona site was previously chosen by the Air Force for the ARS to avoid the Tulsona Creek Burn area and pond systems to the west where greater amounts of shrub and herbaceous cover types are present (USAF, 1989a).

Within the site boundaries, HAARP facilities were located to avoid the shrub and herbaceous cover types when consistent with logistical and operational constraints. This effort was largely successful as evidenced by the proportionally low acreage of herbaceous and shrub cover types in the facility footprints.

In areas where trees are cleared but no fill is placed, habitat impacts could be minimized by leaving the cuttings in place on the ground surface. Such a practice would provide shelter and short-term forage for a variety of wildlife species.

After completion of borrow removal, the pits would be reclaimed and revegetated by the contractor. When possible, gravel would be extracted to avoid sensitive vegetative communities and wetlands.

Wetlands. Complete avoidance of all wetlands is virtually impossible in this region for a project of this size, since the region supports such a high proportion of wetlands. Despite this, an effort was made to avoid wetlands when locating the project facilities. This effort was extremely successful as evidenced by the disproportionately low percentage of total wetlands affected by the project (38 percent) as compared to the entire site (70 percent). In addition, the more valuable open water and emergent (herbaceous) wetlands were successfully avoided as evidenced by the lower percentage to be potentially impacted (2 percent) as opposed to their abundance on the entire Gakona site (23 percent).

Minimization of wetland fill was required as part of the request for proposal for the design and construction of the IRI. Prospective contractors (bidders) were required to develop approaches and designs that would minimize wetland fill. This was an evaluation criterion for the proposals. As a result, the selected facility design incorporated a sensitivity for wetland fill and minimized the amount of fill.

4.2.2 Clear Site

Vegetation. The project would have no significant impact to vegetation if constructed at the Clear site. Nearly equal amounts of vegetation would be affected at the Clear AFS property (41 acres) and the Bear Creek location (about 36 acres) (Table 4.2-3). The consequences to vegetation and wetlands from the required reclamation of the Gakona site if the Clear site is chosen are discussed below in Section 4.2.3 No Action Alternative.

The construction of the IRI on the Clear AFS property would solely affect closed conifer forest (37 acres) (Table 4.2-3). Construction of the diagnostics and access roads on the Clear AFS property would solely affect open conifer forests (4 acres). The loss of these relatively small amounts of forests would not detract from their regional abundance or importance. Such open and closed conifer forests have limited value for most wildlife and also have minimal value as timber resources. The forests at the Clear AFS property are more valuable than those at the

TABLE 4.2-3. AREAS OF UPLAND AND WETLAND COVER TYPES (IN ACRES) AFFECTED BY THE HAARP FACILITIES AT THE CLEAR SITE

Cover Types[1]	IRI	Diagnostics and Roads on Clear AFS				Bear Creek Location[2]	TOTAL
		Optics and Magnet-ometer	LIDAR	Access Roads	TOTAL		
Closed Conifer	37	0	0	0	0	0	37
Open Deciduous	0	0	0	0	0	<1	<1
Open Conifer	0	1	<1	3	4	0	4
Wet Open Low Shrub PALUSTRINE SCRUB/SHRUB	0	0	0	0	0	36	36
TOTAL	37[3]	1	<1	3	4[3]	36[3]	78[3]

[1] Cover types (capitalized) follow Cowardin et al. (1979), all others follow Viereck et al. (1986).
[2] Bear Creek Location includes the ISR, VIS and access road.
[3] Since the values have all been rounded to the nearest whole number for presentation purposes but the actual fractions were used in sums, the totals of the IRI, diagnostics and roads, Bear Creek location and overall total do not sum.

Gakona site because there are more shrubs. Impacts to vegetation at the Bear Creek location will be more important than at the Clear AFS property because of the shrub (about 36 acres) and deciduous habitats (< 1 acres) that will be affected. Shrub and deciduous cover types are more valuable to wildlife than conifer forest (see Section 3.3) (M&E/H&N, 1992a) and are less common in the region than the conifer forests (ADNR, 1992a).

Wetlands. The construction of the HAARP facilities at the Clear site could substantially affect wetlands. No wetlands would be affected at the Clear AFS property, but the majority of the affected area at the Bear Creek location is wetland (Table 4.2-3). All of the wetlands affected at the Bear Creek location would be palustrine scrub/shrub (36 acres), dominated by alder, willow, and labrador tea. These wetlands, although locally common along the terraces above the Nenana River (USFWS, 1992b), are important to wildlife and are less common than palustrine forested wetlands.

Mitigation. Although there would be no significant impact from the project to vegetation, there are a few mitigative steps that could be undertaken to further minimize impacts or to offset impacts. The design of the IRI facilities minimized impacts to vegetation as discussed above for the Gakona site.

Vegetation. The berm constructed for the ISR would be vegetated according to recommended Alaskan practices. No other mitigation is necessary.

Wetlands. The wetland impacts associated with the Bear Creek location would be minimized where possible by slight changes in the location of the IRI and VIS. Such slight adjustments would reduce the amount of palustrine scrub/shrub wetlands affected, at the expense of palustrine forested wetlands.

4.2.3 No Action Alternative

The no action alternative would result in no impacts at the Clear site, but would have a positive impact at the Gakona site due to its near-term reclamation. The positive impact would involve the revegetation of the graveled surfaces over time.

4.3 MAMMALS

The construction and operation of the HAARP facility at either the Gakona or Clear sites would not cause significant impacts to mammals. A significant impact is defined as one that would cause a noticeable effect on mammal populations.

Potential impacts of the project on mammal populations include: (1) removing, or preventing the use of, important habitat, (2) interfering with movement patterns, and (3) direct human-caused mortality. Lost mammal habitat includes all areas which would be filled, cleared of vegetation, and/or fenced. Different aspects of the HAARP facility were evaluated to determine those which would potentially impact the mammalian species of concern. The physical barrier created by fences around the IRI facilities has the potential to interfere with migrating moose and caribou, causing them to slightly alter their course. Increases in human-caused mortality, through off-site hunting, poaching, and collisions with motorized vehicles, could directly result from construction and operational activities. This potential impact would be greatest during construction, when personnel and vehicular traffic would be at a maximum, and would be lowest during the periods between experiments, when minimal personnel would be present.

Impacts were evaluated for the species of concern identified in Section 3.3. These species include moose, black bear, brown bear, furbearers and other small mammals and were selected based on their possible occurrence at the Gakona and Clear sites, and their economic importance as a subsistence resource.

4.3.1 Gakona Site

There would be no significant impacts to mammals associated with construction of the HAARP facility at the Gakona site. Minor impacts are discussed below.

Moose. Potential impacts to moose at the Gakona site include loss of habitat, interference with migration patterns, and increased human-caused mortality. The HAARP project would directly

remove, through clearing, filling or fencing, approximately 51 acres of habitat, mostly conifer forests. Fences around the on-site diagnostic facilities would limit access to several additional acres of habitat.

The amount of lost annual browse can be calculated using the data for the OTH-B southwest transmit sector (USAF, 1991). The 51 acres required by the project will remove about 104 pounds of browse per year, representing about 26 percent of the winter requirement of one adult moose. Loss of this amount of browse would not result in a significant impact to moose, because forage is presently under-utilized and common in the region (AEIDC, 1988b). Therefore, moose would be able to off-set these losses by eating elsewhere.

During migration, the physical barrier from the restriction fences around the facilities could force moose to travel up to an extra mile to go around. Such increases could possibly decrease survivorship in animals that are nutritionally stressed (starving) and if forage were to be limiting. This situation is not likely the case in this region, and therefore, additional energy expenditures from travelling around fenced areas should not result in noticeable impacts to the moose population.

There is a potential that moose may enter an open gate, go over, or break through fences and become trapped inside the enclosures. A moose trapped inside the enclosure could harm itself or the facility and therefore would need to be removed. It is expected however, that this would occur very infrequently.

An increase in the amount of potential human-caused mortality (additional collisions with automobiles, hunting, and poaching) could result from the construction and operation of HAARP facilities. This impact would be at a maximum during the construction of the facility when the greatest number of people will be involved in the project.

Caribou. Possible impacts on caribou involve interference with migration and increased human-caused mortality. Some caribou have been documented to migrate through the project area, but

impacts are expected to be minimal because the major migration routes do not traverse the project location and caribou spend limited time in the Gakona region. Habitat loss is not expected to be significant because available information indicates that caribou do not summer or winter in the project area or utilize it as a major foraging location during migration.

Black Bear. Black bear would potentially be affected through habitat loss. However, the conifer forest cover types, which comprise the majority of the impacted habitat, are not high quality black bear habitat. Another potential impact is increased human-caused mortality, but this would be inconsequential.

Brown Bear. As indicated in Section 3.3, the Gakona site provides little habitat for this species and use is correspondingly limited. Thus, project impacts are not expected to be significant.

Gray Wolf. Potential impacts to this species include habitat loss, reduction in food supplies, and direct mortality. Habitat loss is not expected to be significant since the lost habitat would be a relatively small proportion of the large home range of a wolf pack. Since the project would not significantly affect prey species such as moose or caribou, it would also not significantly affect wolves.

Small Furbearers. Potential impacts upon furbearers at the Gakona site include loss of habitat and increased human-caused mortality. For aquatic species (e.g., beaver and muskrat), impacts are not expected to occur since wetland and aquatic habitats were largely avoided during facility siting. For more terrestrially-oriented species, impacts are not expected to be significant because of the generally poor productivity of the habitat types lost (conifer forests). Human-caused mortality would not be significant.

Other Species. There would be no significant impacts to other mammalian species because of the relatively small amount of habitat that would be lost as compared to the region and because the habitat that would be affected contains no highly sensitive habitat for mammals.

Borrow Areas. The potential borrow sources associated with the Gakona site all provide winter moose range and black bear cover. Borrow area A-1 has the potential for use by aquatic furbearers because of the presence of open water. All of the proposed borrow removal areas, except A-1, are potentially used by beavers because of the high proportion of deciduous trees (preferred food) and their proximity to fresh water.

Mitigation. Impacts from lost habitat were minimized by avoiding high quality habitats in the region during the delineation of the site boundaries for the OTH-B project and the subsequent siting of the HAARP facilities within the property. Based upon an evaluation of habitat values, the original delineation of the site boundary for the OTH-B project purposely avoided the aquatic areas to the west and the 40-year old burned area to the northeast (USAF, 1989a). These areas support vegetation that provides a relatively high quality and quantity of moose forage. Within the property boundary, locating the HAARP facilities mostly in conifer forest habitat types, with their relatively poor standing crop of available forage, further minimizes the loss of forage.

A contingency plan to remove any large animal that might get inside the fences would be prepared. The design of the fence would minimize the possibility of animals breaching it. The contract specifications for the fence around the IRI calls for gates to be installed in the corners which would facilitate removal of any animal that might venture inside the enclosure.

4.3.2 Clear Site

Construction of the HAARP facilities at the Clear site would affect mammals in much the same manner as discussed above for the Gakona site. These impacts, however, would be minimal and not significant. Implementation of this alternative would also be accompanied by the near-term reclamation of the Gakona site and its associated positive impacts to mammals. These impacts are discussed in Section 4.3.3 No Action Alternative.

Moose. The construction and operation of the HAARP facility would not adversely effect moose migration due the facilities limited areal extent. Minimal increases in direct, human-caused

mortality, through hunting, poaching, and collisions with motorized vehicles, would result from construction and operational activities.

The construction of the proposed HAARP facilities at the Clear site would remove, through clearing, filling or fencing, approximately 41 acres of primarily upland, young mixed conifer deciduous habitat at the Clear AFS property and 37 acres of conifer and shrub habitat at the Bear Creek location. Assuming that habitats such as these are more productive than those at the Gakona site and provide about 4 pounds of browse per acre per year (AEIDC, 1988b), the total amount of lost browse would equal about 312 pounds per year. The loss of some browse as result of the construction of the HAARP facility at the Clear site would have no significant impact on moose due to the abundant available browse in the areas surrounding the Clear AFS property and around the Bear Creek location. Because this area is only infrequently visited by caribou and the region is not considered prime range, the lost browse impacts to caribou are not significant.

The reclamation of the Gakona site calls for scarification of the gravel surfaces to facilitate establishment by browse plant species. Moose would benefit from this increase in available browse.

Black Bear. Black bear would not be affected by the HAARP facility because the loss of habitat acreage would be minimal compared to the home range of the bear. The potential den would be lost, but observations indicate it is inactive.

Brown Bear. The brown bear, like the black bear, would not be affected by the HAARP facility. The potentially affected 77 acres of habitat would be insignificant to the home range of the bear, which is 10 to 50 square miles.

Gray Wolf. No significant impact to wolves would be expected. The loss of available habitat would be minimal compared to the large home range of a wolf pack. Furthermore, sources of

food, such as moose, would not be reduced by the construction and operation of the proposed project.

Small Furbearers. There would be no impact on aquatic species (e.g., mink, beaver and muskrat), since the Bear Creek location is situated approximately 2000 feet north of Bear Creek and 1500 feet west of the Nenana River. There would also be negligible impact to terrestrial furbearers because the amount of lost habitat would be minimal.

Other Species. There would be no significant impacts to other mammalian species because of the relatively small amount of habitat that would be lost as compared to the region and because the habitat that would be affected contains no highly sensitive habitat for mammals. A slight positive impact would result from the near-term reclamation of the Gakona site.

Mitigation. Impacts to mammals could be mitigated using some of the same approach discussed above for the Gakona site.

4.3.3 No Action Alternative

The selection of the no action alternative, and the selection of the Clear site alternative, would result in the near-term reclamation of the Gakona site and would therefore result in a positive impact to mammals. The reclamation would result in the revegetation of the graveled areas which would provide food for browsing mammals such as moose and snowshoe hare and food and cover for smaller mammals.

Increases in human-caused mortality, through hunting, poaching, and collisions with motorized vehicles, could directly result from construction and operational activities associated with the reclamation effort. Mitigation of human caused mortality during reclamation would be similar to that described in Section 4.3.1.

4.4 BIRDS

This section addresses the potential impacts of the HAARP project on birds at the Gakona and Clear sites and discusses potential mitigation measures. Potential impacts to avian species have been characterized as follows: (1) habitat loss, (2) disturbance to nesting trumpeter swans and raptors, and (3) collisions with project structures.

4.4.1 Gakona Site

Habitat Loss. Approximately 51 acres of habitat, the majority of which (94 percent) is black spruce forest (Section 4.2), would be impacted by the construction and operation of the HAARP facility at the Gakona site. This habitat type had the lowest density of breeding passerines of the habitat types sampled, averaging about 12 territories per 25 acres (Section 3.4). This translates into a potential loss of approximately 20 breeding territories, a level expected to have a negligible effect on passerine populations.

The HAARP facility would have negligible impact on palustrine emergent wetlands (1.0 acres) and no impact on open water areas. Thus, impacts to breeding waterfowl would be minimal. Few raptor nests were located near the facility locations (Section 3.4). With the exception of small areas of tall deciduous or mixed forest habitat located on small hummocks within the largely black spruce wetland habitat of the area, the facility sites provide poor quality breeding habitat for woodland raptors. Loss of this habitat would have a negligible effect on nesting raptors.

In summary, little or no high quality avian habitat would be destroyed that is not common in the immediate surrounding region. Thus, the effects on avian resources due to habitat loss are expected to be minimal. Habitat loss at borrow locations would not be considered significant, unless the bald eagle nesting trees at sources P-1 and A-5 were destroyed.

Disturbance. The proposed locations of the IRI and diagnostic equipment would be within one mile of four trumpeter swan nests and five swan brood-rearing areas. Since the USFWS recommends a one mile buffer from human activity, there is some potential for negative impacts to trumpeter swans. However, this level of disturbance would potentially affect only a small number of nests and broods and should not have a serious effect on the population as a whole.

Only one raptor nest (great gray owl) was located within one mile of the facility locations. As with trumpeter swans, the number of raptors which would be disturbed during construction and operation of the facility is expected to be insignificant as compared with regional population levels.

Active bald eagle nests were found within one mile of borrow sources A-4, A-5, and P-1 and a trumpeter nest was located within one mile of source P-1 during avian studies. Thus, while some potential disturbance to these species may potentially occur during gravel removal, the level of disturbance would probably be minimal and temporary and the effects on the breeding population of these species would not be significant.

Bird Collisions With Structures. A number of factors influence the potential for birds colliding with the HAARP facilities. Only those birds flying within flight paths which intersect the antenna structures and which fly below the maximum height of the antenna masts are at risk of collision. Factors which influence the potential severity of collision mortality on bird populations include the number of birds flying through the site, the population status of these species (abundant species can sustain higher levels of mortality without severe impacts to the population), flock size, and the time of day when species are active (nocturnal migrants are more prone to collisions due to decreased visibility). It is not possible to determine the probability of collisions or to precisely predict the number and species of birds which would collide with the project structures because quantitative techniques to precisely predict the number of collisions are not available (USFWS, 1989).

Bird collisions with the HAARP facilities would likely be limited to the IRI antenna structures and the VIS. The other facilities and instruments would pose a negligible risk to flying birds because of their minimal size and height. As discussed in Section 2.2.3, the IRI design consists of 180 guyed antenna elements extending about 70 feet above the ground; the majority of the obstructed airspace is in the range of 30 to 50 feet agl. The VIS antenna consists of a transmitter, with one 100-foot and four 50-foot guyed towers, and a receiver comprised of four 5 foot high antenna masts. The potential risk of species groups colliding with the HAARP facility, as a function of factors that influence collision, are summarized in Table 4.4-1.

Based upon this analysis, the collision potential for geese, raptors, and shorebirds is considered to be low at the Gakona site. The risk of collision is considered higher for ducks, swans, and passerines. It is expected that collisions of geese, eagles, hawks, and falcons with the antenna structures would be rare events. Significant numbers of geese are not expected to collide with the antenna structures since most movements over this site appear to be high altitude migratory movements and because the number of geese migrating through the site appears to be small. Eagles, hawks, and falcons are extremely maneuverable in flight, possess excellent vision, and are mainly active during daylight hours. Collision mortality with man-made objects is generally considered uncommon for these raptor groups (Olendorff et al., 1981).

Owl and shorebird collisions may occur more frequently but should still be relatively uncommon. Among raptors, the risk of collision is considered highest for owls because of their nocturnal foraging habits, the lower visibility of the guy wires during reduced light levels, and the non-migratory tendencies of these species. Because of their in-flight maneuverability during the day, their propensity to migrate at high altitudes at night (Drury and Keith, 1962; Nisbet, 1963), and because of the low number of birds which apparently migrate through the site, high numbers of shorebird collisions are not expected to occur.

Ducks and passerines may have higher probabilities of colliding with the structures, and small numbers of collisions may occur throughout the life of the project. Such collisions are expected to be mainly confined to poor visibility periods and/or inclement weather events. Ducks are

TABLE 4.4-1. FACTORS WHICH INFLUENCE COLLISION RISK POTENTIAL BY SPECIES GROUP AT THE GAKONA SITE

Factor[1]	Ducks	Geese	Swans	Eagles/ Hawks	Falcons	Owls	Shorebirds	Passerines
Abundance at Site	+	-	+	0	-	-	-	0
Population Status	0	-	0	-	+	-	-	-
Flight Path	-	-	0	0	-	-	-	0
Flight Altitude[2]	0	-	0	0	-	+	0	0
Flock Size	0	0	0	-	-	-	0	0
Flying Ability	-	0	+	-	-	-	-	-
Visual Acuity	-	-	-	-	-	-	-	-
Wing Span	-	0	+	+	0	+	-	-
Nocturnal Migration	+	+	+	-	-	+	+	+
Local Breeder	+	-	+	+	-	+	0	+
Susceptibility to Collisions	+	-	+	-	-	-	0	+

[1] Ranks: - = low risk; 0 = moderate risk; + = high risk.
[2] Average of nocturnal and diurnal tendencies.

largely nocturnal migrants and are known to frequently collide with man-made objects, especially power lines (Thompson, 1978; Anderson, 1978). Passerines also frequently collide with man-made objects (e.g., Avery et al., 1978), and the severity of collision mortality is probably proportional to the height of the structure. The relatively short height of the antenna elements would probably limit the number of collisions, although some collisions are probable due to the size of the facility.

Swans, especially trumpeter swans, are probably the group most at risk of colliding with the antenna structures at this site because of the pulse-like nature of swan migration, when large numbers pass through the site in a short period of time, the propensity of this group to migrate in October when weather conditions are often poor, and the tendency of this group to fly lower during low cloud ceiling periods. In addition, local movements by trumpeter swans, especially juveniles, are also expected to contribute to this collision mortality. Since swans generally fly above the 70 foot antenna heights, there would be no significant impact to the swan population.

Threatened and Endangered Species. There are no known threatened and endangered bird species at the Gakona site (USFWS, 1992h).

Mitigation. Mitigation for in-kind habitat loss would not be advisable since no critical or scarce habitat is being removed by the project. Mitigation of habitat loss and collision mortality was considered in the selection of the preferred design. As discussed in Section 2.0, two designs were initially considered. The dual array would require approximately twice the antenna masts, support cables, and filled area compared to the stacked array alternative. Habitat loss and collision mortality was substantially reduced by selecting the stacked array as the preferred design alternative.

Bird collisions with the IRI array and sounder would be minimized by increasing the visibility of the structures' guy wires. The usual approach involves attaching yellow aviation marker balls at regular intervals on all guy wires at heights greater than or equal to 50 feet above ground

level. Aviation marker balls have been used successfully to reduce bird collisions with power lines during daylight hours (Beaulaurier, 1981; Faanes, 1987).

Concern over the potential effect of RFR on bird migration and health is discussed in Section 4.13. It was concluded in Section 4.13 that there is an insignificant affect from RFR on bird migration and health.

4.4.2 Clear Site

Impacts to birds at the Clear site would be similar to those expected at the Gakona site. Construction of the HAARP facility at the Clear site would be accompanied by the slight positive impact association with the eventual revegetation of the Gakona site, creating nesting habitat for passerine birds.

Habitat Loss. Approximately 78 acres of habitat, including 41 acres on the Clear AFS property and 36 acres on the Bear Creek location would be impacted by the construction and operation of the HAARP facility at the Clear site. The majority of the habitat at the Clear AFS property would be conifer forest, whereas, the majority of the habitat at the Bear Creek location would be palustrine scrub/shrub wetland. Negative impacts to habitat would be greater than that at the Gakona site because of the better quality habitat at the Clear site. There would be no impact to waterfowl breeding because no open water exists at either the Clear AFS property or the Bear Creek location. In general, effects on avian resources due to habitat lost to the project are expected to be minimal.

Disturbance. The potential disturbance to breeding trumpeter swans is expected to be minimal because there are no bodies of open water large enough within a mile of the Clear site to be used by swans for breeding or rearing. Disturbance to raptor or eagles is expected to be negligible because no nests were documented at the Clear site.

Bird Collisions With Structures. As would be the case at the Gakona site, there is a potential that flying birds could collide with the IRI and VIS structures. This potential negative impact is likely to be greater than that at the Gakona site due to the greater numbers of sandhill cranes that migrate through the area and the positioning of the VIS in the river valley at the Bear Creek location. Sandhill cranes, although typically high altitude migrants (ABR, 1992), have increased collision potential due to the great numbers of birds going through the area. The relatively narrow river valley at the Bear Creek location could cause a funneling of shore birds and waterfowl, particularly for local movement as the birds course the river. As stated above for the Gakona site, the actual number of collisions is not possible to predict.

Threatened and Endangered Species. There will be no affect to the critical habitat of the threatened arctic peregrine falcon or the endangered American pergrine falcon, or their nests. Both the arctic and American peregrine falcon are known to migrate through the Clear region (USFWS, 1992d) and therfore could potentially collide with the HAARP antenna structures. However, this potenital would be minimal as the antenna structures are 100 feet or less in height. Therefore, construction and operation of the HAARP facility at Clear would not likely affect the populations of either the arctic or American peregrine falcon.

Mitigation. Minimization of bird collision with the project structures would be conducted as described above for the Gakona site.

4.4.3 No Action Alternative.

The no action alternative would have none of the negative impacts on birds associated with the selection of either the Gakona or Clear sites. Furthermore, selection of the Clear site or the no action alternative would result in the near-term reclamation of the Gakona site. The revegetation of the graveled areas at the Gakona site would provide nesting and foraging habitat for birds, resulting in a slight positive impact.

4.5 AQUATICS

This section discusses the potential impacts to aquatic resources which could occur as a result of construction or operation of the HAARP facility, and the mitigation steps that could be taken to offset these impacts. As explained below, construction and operation of the HAARP facility would not result in significant impacts to aquatic resources.

4.5.1 Gakona Site

Site Construction and Operation. Aquatic resources of concern are not located within the immediate area identified for construction of the transmitter, structures, or access roads. Thus, there would be no direct impacts to aquatic resources. Potential indirect impacts from construction site runoff reaching Tulsona Creek or the Copper River would be associated with sediments from site runoff or those which could arise from erosion of the watershed due to changes in hydraulic characteristics (Section 4.6.1).

Few, if any, impacts to aquatic resources are anticipated under normal operation of the facility. Service water demand, met by the 400 foot deep on-site well, would be much too low to have any effect on aquifers or the recharge of Tulsona Creek. In addition the well's depth and separation from surface waters by the permafrost would preclude significant impact to surface waters or Tulsona Creek. Impacts to aquatic resources could arise from accidents such as introduction of diesel fuel to the environment during fuel delivery or transfer. However such incidents would seldom, if ever, occur.

The greatest potential for impact to aquatic resources would be associated with gravel removal from areas bordering Tulsona Creek or the Copper River. Impacts would be primarily associated with runoff, erosion and siltation. A number of potential gravel source areas exist along the Copper River, for which descriptions are included in Section 2.3.1. However, the Copper River is very turbid from glacial sediments and the minimal additional sediments from mining activities would not be noticeable.

Some borrow removal scenarios for area P-1 include diversion of the section of Tulsona Creek in the Copper River floodplain west of the existing Alaska Department of Transportation (ADOT) borrow pit. Such a diversion would have direct impacts to habitat and water quality in both water bodies, and have the potential to affect spawning and migration of important fish resources. Areas P-1 and A-1 also contain small ponds which may also be impacted.

Mitigation. Impacts associated with gravel removal would be mitigated by construction of berms to contain runoff from overburden and gravel stockpiles, maintenance of 100-yard buffers between borrow areas and water resources, and rehabilitation of excavated areas to productive habitat, as required.

4.5.2 Clear Site

The following section discusses the potential impacts to aquatic resources which could occur as a result of construction or operation of the HAARP facility, and the mitigation steps that could be taken to offset these impacts. As explained below, construction and operation of the HAARP facility at the Clear site would result in few if any impacts to aquatic resources. The selection of the Clear site would be accompanied with the reclamation of the Gakona site. Impacts associated with this reclamation are discussed below under in Section 4.5.3

Site Construction. No significant aquatic resources are located within the area identified for construction of the transmitter, structures, or access roads. Thus, direct impacts would not occur as a result of the construction of HAARP facilities at either the Clear AFS property or the Bear Creek location. There could be limited runoff of sediments to Bear Creek and the Nenana River during construction activities at the Bear Creek location. If there is runoff, the potential exists for the introduction of low concentrations of construction related pollutants such as fuel or lubricants to Bear Creek and the Nenana River. The gentle slope of the terrain around the Bear Creek site would reduce the likelihood of erosion during runoff periods.

Suspended sediments could impact Bear Creek water column resources by increasing turbidity levels, which could reduce light penetration affecting productivity of algae or aquatic plants, and reduce the success of sight-feeding organisms. Any sediment runoff into the Nenana River as a result of construction activities would be insignificant because of the high existing levels of turbidity in the Nenana River. Increased deposition in Bear Creek could result in changes in stream hydrology and habitat alteration, affecting species that use the bottom habitat to feed, spawn, or live. Impacts associated with introduction of pollutants from site runoff could consist of chronic toxicity effects to sensitive life stages such as larvae or juveniles.

Facility Operation. No impacts to aquatic resources are anticipated during the operation of the Clear AFS property and the Bear Creek location. Impacts to aquatic resources in Bear Creek and the Nenana River nearby the Bear Creek location could arise from an accidental fuel spill during delivery. The likelihood of such an incident is negligible.

Mitigation. Impacts associated with gravel removal would be mitigated by construction of berms to contain runoff from overburden and gravel stockpiles, maintenance of 100-yard buffers between borrow areas and water resources, and rehabilitation of excavated areas to productive habitat, as required.

4.5.3 No Action Alternative

None of the limited impacts to aquatic resources associated with the construction of the HAARP facility at either the Gakona or Clear sites would occur. The required near-term reclamation of the Gakona site would result in temporary, limited runoff and siltation during gravel removal. However, this would not affect aquatic resources on the Gakona site.

4.6 HYDROLOGY AND WATER QUALITY

This section evaluates the potential impacts of construction and operation of the HAARP facility which may affect surface and groundwater resource quality. Mitigation measures intended to offset these impacts are discussed. No significant impacts to surface and groundwater resources are anticipated from the construction and operation of the facility.

4.6.1 Gakona Site

Potential Construction Impacts. Potential impacts associated with site construction include degradation of the permafrost layer, alteration of drainage patterns affecting surface runoff characteristics, and impacts to surface and groundwater quantity and quality. Thermal characteristics of the soil might be altered by removal of vegetation and organic matter, since they insulate permafrost soils. Road and building construction, pile installation, or alteration of drainage patterns could also alter thermal properties of the soil surface. Permafrost alteration might result in increased erosion, subsidence (settling) of soils, and problems relating to slope stability.

Gravel removal could cause erosion, stream siltation, and water quality degradation. Increased turbidity levels may result from both gravel extraction as well as construction and maintenance of access roads. All potential gravel source areas identified (P-1, P-2, A-1, A-4, and A-5) are near the Copper River. Area P-1 is also crossed by Tulsona Creek, while the western edge of A-4 borders the floodplain of the Chistochina River. Site-specific impacts associated with excavation schemes may further induce hydrological and water quality impacts. For example, several scenarios developed for gravel removal from area P-1 involve either temporary or permanent diversion of Tulsona Creek, that could result in bank erosion and associated water quality impacts (M&E/H&N, 1989a).

Potential Operational Impacts. Potential impacts to hydrology and water quality from the operation of the facility would be associated with disposal of water and wastewater, solid waste,

hazardous waste (solvents and cleaners, contaminated lubricants, antifreeze, paints, etc.), fuel transfer and storage, and will be managed in accordance with applicable state and federal laws and permitting requirements.

Mitigation. In addition to avoiding large-scale alteration of the soil surface through use of the elevated ground screen, utilization of thermosyphons for antenna arrays and suitable insulation for road and pad construction could be used to limit disturbance of the permafrost within the grid area.

A Spill Prevention, Containment, and Countermeasure (SPCC) Plan will be developed to minimize the potential of impacts due to accidental fuel spills during facility operations and fuel transfer from delivery trucks . Provisions could be required to periodically remove snowmelt and storm water from the containment areas so that capacity for emergency storage is not diminished.

To minimize the potential for permafrost degradation and possible resulting hydrology and water quality impacts, areas on the proposed site subject to effects from heated buildings or fuel storage tanks could be protected by either board insulation, gravel pads, or active refrigeration, or some combination thereof.

4.6.2 Clear Site

Below is a discussion of the consequences of selecting the Clear site, and possible mitigation efforts that could be implemented. A discussion of the reclamation effort required at Gakona and its consequences and mitigation as it relates to hydrology and water quality is included under Section 4.6.3 No Action Alternative, Gakona site.

Potential Construction Impacts. Potential construction impacts to the hydrology of the Clear site include alteration of drainage patterns and effects on impacts to surface and groundwater

quality. Disturbance of the thermal balance at the ground-air interface is inconsequential as the soil is well drained and typically low in ice content.

Because of the high permeability of the substrate material at the Clear site, the implications of changing the surface water drainage patterns are not particularly significant. Removal of the surface layer in the area of construction will increase the rate of infiltration of water into the ground.

Large obstructions such as buildings, parabolic antennas, and earthen dikes could accumulate large volumes of drift snow. When melted in the spring, this localized increase in run-off and could potentially increase erosion and/or result in localized ponding of water.

Gravel removal from borrow areas could cause erosion, stream siltation, and water quality degradation. Increased turbidity levels in surface water could negatively impact aquatics and mammals alike.

Potential Operational Impacts. Operation of the HAARP facility at Clear would include the use/generation of products that could negatively affect water quality in the region. This includes water and wastewater, solid waste, hazardous waste products (paints, solvents, anti-freeze), petroleum products (diesel fuel, coal, motor oil, fluids), and other similar materials.

Mitigation. Proper arctic construction practices could be employed to minimize hydrological impact during construction. This includes such measures as obtaining gravel from locations well away (more than 100 yards) from surface water sources and limiting the level of disturbance to the site through construction scheduling and on-site engineering and environmental monitoring. In addition, locations that serve as borrow areas could be returned to productive habitat through a vegetation restoration program.

Snowmelt and storm water drainage could be managed through proper site grading and perimeter interceptor ditches at both the Clear AFS property and the Bear Creek location. Vegetation

restoration projects could be implemented to secure the soil matrix and limit erosional and siltation problems after construction.

Snowdrift control could be conducted by using accepted engineering practices around the site, or if more severe drifting problems are predicted, a wind tunnel modeling effort could be conducted for the sites and equipment. This effort may be particularly appropriate at the Bear Creek location where topographic funneling effects may induce locally strong winds and significant snow drifting problems.

Operation of the HAARP facility should utilize the existing Clear AFS utilities to the greatest extent possible. This includes use of the water supply, wastewater treatment systems, and hazardous material and petroleum products handling and storage facilities. This action would mitigate potential water quality problems by utilizing in-place and accepted Air Force systems, thereby eliminating the need for constructing the water supply, wastewater treatment systems, hazardous materials handling and storage facilities, and fuel systems.

4.6.3 No Action Alternative

There would be no hydrology and water quality impacts associated with the no action alternative at the Clear site. There would, however, be some impacts associated with the no action alternative at the Gakona site due its required near-term reclamation. These impacts can be divided into construction and post-construction activities. The construction impacts relate to the efforts associated with the reclamation activity at the site. The post construction impacts relate to persisting conditions that would exist after the reclamation effort is implemented.

During the reclamation "construction effort", it is anticipated that the most significant damage would be the further disturbance of the thermal regime which could lead to subsidence of the soil and the formations of ponds and streams. Loss of vegetation and changes in ground permeability could alter drainage patterns, thereby affecting run-off rate and potentially

producing concentrated flow patterns. Erosion and siltation patterns could develop as a result, leading to potential impacts to surface water quality, such as increased turbidity and decreased ponding and flood control. Decreased permeability of the ground could also alter infiltration rates, which could affect groundwater supply (Section 3.6.1).

Environmental consequences after reclamation construction activities would include further deterioration of the permafrost layer while the thermal and energy exchange is re-balanced. This may result in increased subsidence and deterioration during the re-adjustment process. Preliminary estimates indicate that the final subsided level of the gravel pad and roadway would be at normal grade (total settlement of 4 to 6 feet).

Mitigation of the environmental consequences associated with site reclamation would be strictly limited to the existing gravel pad, and an effort could be made to extract the culverts from the roadway in a season other than the spring when surface water flow is at a maximum. Ditches should be frequently cut across the road to eliminate the possibility of the roadway damming water behind it.

On-site disposal of human and domestic wastes could be prohibited during construction to eliminate pollution of the surface or ground water sources. All domestic and process wastes (wastewater, washdown water, solid wastes, and hazardous wastes) could be stored on-site in approved holding tanks which would be periodically removed and disposed of off-site.

Fuel and other petroleum product spills would be avoided by following a SPCC plan. At a minimum, this SPCC plan would require that fuel transfers and other such activities occur in a designated containment basin, that fuel storage areas be surrounded by a lined containment dike, and that oil spill containment equipment be available at the site.

Further hydrological degradation could be prevented by discouraging access to the site by off-road vehicles. This could be accomplished by cutting a deep water bar at the beginning of the

access road (near the Tok Cut-Off), and possibly concealing the access clearing to the site by using downed trees and other natural products to seal off the clearing.

4.7 AIR QUALITY

This section discusses the potential impacts to air quality associated with construction and operation of the HAARP facility. Mitigation measures for the impacts are also identified. No significant impacts to air quality would result from selecting the Clear site or the no action alternative. With proper mitigation efforts, the Gakona alternative could also be selected without significant impact.

4.7.1 Gakona Site

The construction and operation phases of the project would have different impacts to air quality because of the differences in activities and emissions generators. The primary generators during construction would be construction vehicles which would produce both emissions from combustion engines and fugitive dust. Other less important sources of pollutants during construction would include temporary electricity generators and open burning. The limited and temporary HAARP construction activities would not significantly impact the local air quality. The most important source of air pollutants during the operation of the IRI would be the 15-megawatt (MW) powerplant with its 6 diesel generators. The air quality could be significantly impacted by the operation of the 6 diesel generators necessary to power the IRI, depending upon the amount of their use.

Construction Activities. During construction, potential short-term impacts to local air quality could result from the emissions of internal combustion engines and the dust created by construction activities. An estimated 7,300 haul unit round trips, assuming a haul unit capacity of 22 cubic yards, would be necessary to supply the estimated 160,000 cubic yards of gravel required for construction of the IRI and diagnostic facilities. The borrow sources would likely be located within 24 miles of the IRI site in the Copper River Valley. The actual rate of emissions on any one day would depend upon a number of factors, including vehicle type, hours of operation, and number of vehicles. This information will not be known until contractual arrangements are completed with subcontractors.

During construction, pollutants from other mobile sources potentially include commuting vehicles and fuel transport trucks. All of the anticipated work force would likely commute from areas within 30 miles of the project site. A construction camp is not planned; therefore, there would be no emissions from on-site living facilities. Air impacts from these sources would be comparatively minimal as compared to the large construction vehicles.

Clearing activities could involve burning of slash material under the provisions of an ADEC Open Burn Permit. In addition, the concept of on-site burning of combustible construction wastes is being considered as an option for solid waste disposal. If open burning is to be conducted, the Air Force or its contractor(s) will obtain all required permits.

The Air Force concluded that there would be no significant impact to air quality from anticipated construction activities of the considerably larger OTH-B facilities (USAF, 1989a). Therefore, it can be concluded that air quality impacts from the limited and temporary HAARP construction activities would also not be significant.

Operation Activities. During operation of the IRI and diagnostic facilities air pollutants would be generated from haul trucks, worker vehicles, maintenance vehicles and the diesel-fueled generator plant. The long-term projected increase in daily vehicle miles traveled in the Gakona region is expected to be minimal due to the short-term intermittent use of the facility (4 or 5 times per year) by teams of up to 15 scientists and technicians and the limited number of year-round full-time on-site maintenance and security staff.

The permanent site staff, expected to consist of approximately 4 to 8 people, would likely commute daily from the surrounding area. Whether the visiting scientists would be lodged at the research site or in the surrounding communities depends upon the site chosen for the IRI. It is known that if the Gakona site were to be chosen, the scientists would be lodged primarily in the surrounding communities. Current use of the Tok Cut-Off averages between 325 and 700 vehicles per day (M&E/H&N, 1989b). The additional vehicles (up to 8) that would be used on a continual daily basis by permanent employees and a maximum of 15 vehicles that would be

used by visiting scientists and technicians, about 4 to 5 times a year, would be insignificant as compared to the average daily use of the Tok Cut-Off. Therefore, any added pollutants from these vehicles would be negligible.

The greatest air quality impacts associated with the IRI site are expected from the operation of the 6, 2.5 MW, diesel generators necessary to power the IRI and facilities. The Federal Clean Air Act and the Alaska Air Quality Control Regulations provide standards by which the significance of air quality impacts must be judged. These standards are the National Ambient Air Quality Standards (NAAQS) and the Alaska Ambient Air Quality Standards (AAAQS) .

The Federal Clean Air Act was significantly amended in 1990. However, how these amendments will affect HAARP is uncertain, because the EPA has not yet issued many of the necessary regulations implementing the amendments. Title V of the amendments establishes a new permitting structure that requires all major sources of air pollution to obtain a permit pursuant to the new requirements of the title. Title V requires the EPA to develop regulations that define the requirements for state programs to implement the title. Each state will then have 3 years to develop and submit to the EPA for approval a new operating permit program. ADEC has submitted to their legislature proposed changes to address Title V permitting requirements, but these changes are still pending (ADEC, 1993). Therefore, at the present time, and until the State of Alaska adopts new permitting requirements, the previous regulations apply.

Titles I, III, and IV of the 1990 amendments to the Federal Clean Air Act may also ultimately affect the project. Title I addresses the attainment and maintenance of NAAQS, especially for geographic areas that are not presently in attainment. Title III, which addresses hazardous air pollutants, mandates specific studies to establish whether public health criteria warrant further control of utility emissions of SO_2 and NO_x to alleviate acid precipitation. Since the proposed facility would emit such low levels of SO_2 and is of relatively small size, restriction of SO_2 emissions would not impact the proposed facility. However, the required reduction of NO_x by 2 million tons less than the 1980 levels by the year 2000 could affect the proposed power generating system. This effect will be determined during the permitting process.

The present NAAQS establish minimum federal requirements for 6 pollutants for the purpose of protection of human health. The AAAQS established by ADEC set allowable ambient concentrations for the same 6 pollutants, but vary according to the classification of the airshed. The ADEC requires new sources to obtain a permit to operate. In addition, the project might be subject to new source requirements which include Prevention of Significant Deterioration (PSD) review, New Source Performance Standards (NSPS) and completion of an ambient air quality assessment. PSD review involves review of Best Available Control Technologies (BACT) and air quality impacts to demonstrate compliance with NAAQS/AAAQS and PSD increments. NSPS are set at mean allowable emission rates for new combustion sources.

These standards are used by ADEC in evaluation of potential PSD review. PSD review is necessary if the powerplant emissions exceed 250 tons per year of any one EPA regulated pollutant. In addition, the plant will be required to meet applicable Class II PSD increments as specified in the ADEC regulations.

The USAF will submit an application for a Permit to Operate if the decision is made to proceed with the HAARP at the Gakona site. This decision will be documented in the Record of Decision at the culmination of this NEPA process. The application for the Permit to Operate will follow the regulations in place at that time, whether they are the current ones or new standards implementing the 1990 amendments. Through this process the Air Force will ensure that all applicable federal and state air quality standards and permit requirements are met.

The predicted SO_x and NO_x emission rates reported in the air quality permit for the diesel portion of the proposed OTH-B powerplant (ADEC, 1990) can be used to estimate emission rates for the proposed HAARP powerplant since the same generator sets are proposed for use. As documented in that permit, particulate emissions from these generators would be negligible and are therefore not addressed here.

Current estimates indicate that the powerplant (6 generator sets operating) would consume about 191,800 pounds of diesel fuel per 24 hours of operation. This results in an estimated production

of about 1,870 pounds of SO_x and 13,300 pounds of NO_x per 24 hours of operation. At these emission rates, the plant could operate at full power for about 38 days before exceeding the 250 tons per year threshold of NO_x for PSD analysis. Only NO_x needs to be calculated because NO_x emissions would exceed the 250 tons per year standard before the considerably lesser emitted SO_x. The number of campaigns, during which the powerplant would be operated without exceeding the annual PSD threshold, can be calculated. It is estimated, considering that the powerplant would not operate continuously from the beginning to the end of a campaign, that about 740 tons of fuel would be used in one campaign. Based upon this fuel consumption, about 51 tons of NO_x would be produced during one campaign. Such a rate of emission would allow approximately 5 campaigns per year before exceeding the PSD threshold. This approaches the currently anticipated 4 to 5 campaigns per year. Future additions to the number of campaigns to be held per year could lead to the PSD thresholds being exceeded. In this case, the government could be required to go through the PSD review process. This might require that additional emission control devices be used at the HAARP site.

Predicted maximum concentrations were calculated for a location, approximately 1 mile north-northeast of the site, that is expected to be exposed to the highest levels of air pollutants (refer to Table 4.7-1). The predicted maximum concentrations were calculated based on the screening and modeling of the emissions expected for the OTH-B diesel-fueled powerplant (SEI, 1989; ADEC, 1990). As seen in Table 4.7-1, the predicted maximum concentrations are not expected to exceed any of the SO_x or NO_x standards for any of the averaging periods. However, as shown in Table 4.7-1, the estimated emissions of NO_x are nearly 90 percent of the allowable annual Class II increment. Use of more detailed plant design and fuel information in an updated screening modeling and further PSD review (if warranted) in support of the air quality permit process should further refine these potential impacts.

The impacts of the expected emissions from the currently proposed generators would be modeled and evaluated during the ADEC and PSD (if necessary) permitting process. This modeling would include the potential to degrade the Class II airshed and aesthetic values associated with the numerous scenic vistas at the Wrangell-St. Elias National Park and Preserve as well as the

effects on ice fog formation. The planned intermittent use of generators lessens the potential for problems associated with ice fog.

TABLE 4.7-1. ALASKA AND NATIONAL AMBIENT AIR QUALITY STANDARDS FOR SO_X (MEASURED BY SO_2) AND NO_X

Pollutant	Averaging Period	AAAQS NAAQS Conc.[1] ($\mu g/m^3$)	AK PSD Increment ($\mu g/m^3$)	Class II Increment ($\mu g/m^3$)	PSD Predicted Maximum[2] ($\mu g/m^3$)
SO_2	3-hr	1300	512	512	512
SO_2	24-hr	365	91	68	14.6
SO_2	Annual	80	20	5.0	1.34
NO_x	Annual	100	NA[3]	6.2	5.44

[1] AAAQS and NAAQS are equal.
[2] Estimated from SEI, 1989. Represents the concentration at the maximum receptor which was estimated to be about 1 mile north-northeast of the site.
[3] NA = Not Applicable.

Mitigation. The government would ensure that the powerplant facility emissions would not significantly degrade the air quality of the Gakona region by requiring that the powerplant meet all required federal and state regulations (including PSD requirements, if necessary) on air emissions.

4.7.2 Clear Site

Below is a discussion of the impacts to air quality as a result of selecting the Clear site, and possible mitigation efforts that could be implemented. A discussion of the reclamation effort required at Gakona and its consequences and mitigation as it relates to air quality is included under Section 4.7.3 No Action Alternative.

Impacts on air quality at the site can be divided into two sub-sets, construction and operation. These two subject areas are addressed below. Construction impacts would include emissions from heavy and light equipment associated with constructing the HAARP facility and fugitive dust that could be generated from earthmoving activities. In addition, some open burning of trees and other vegetation may be necessary.

Operational impacts would be associated with the increased loading on the existing coal-fired powerplant at Clear AFS or from increased loading on the local power utility's generation stations if the commercial grid were to be used. Additionally, there would be an increase in emissions from vehicles and small equipment associated with day-to-day operations.

The relatively small and temporary construction effort required to build the HAARP facility would have an insignificant impact on air quality in the region. The episodic nature of the HAARP operation and the small amount of increased emissions of the existing powerplant to meet these needs would also be considered negligible.

Construction Activities. Short term impacts associated with construction of the HAARP facility at Clear could result from the emissions of internal combustion engines, as well as the dust created by heavy construction and earth-moving activities. An estimated 31,000 cubic yards of gravel is required for construction of the HAARP facility at Clear, equating to about 1500 haul unit round trips (assuming a 22 cubic yard capacity truck). There are numerous borrow material sources within the Clear AFS area, and haul distances are projected to be short (less than 1 mile). At the Bear Creek location, the distances may be somewhat longer since gravel sources do not appear to be as numerous. However, as an improbable worst case scenario, gravel would need to be hauled about 10 miles to Bear Creek. Development of Bear Creek requires roughly half of the total gravel required at the Clear site, or 15,000 cy. The actual amount and rate of emissions would depend on the type of equipment being used, the number of vehicles being used, and their relative mechanical condition.

In addition to heavy equipment pollution, commuting cars and utility vehicles would also be used in the construction process. It is anticipated that the majority of the construction work force (about 30 people) would come from the local economy (Healy, Nenana, Anderson), with only several specialists being imported for specific construction tasks. Thus, commuting distances are short and total emissions from this source would not be significant. In addition, there is no construction camp planned, so there would be no additional emissions for on-site living facilities.

Some burning of vegetation may be conducted in association with the construction clearing activities. Open burning permits would be required from the Alaska Department of Environmental Conservation. Additionally, combustible construction debris and crating material may be disposed of by burning. Again, the proper permitting would be required from ADEC for open burning activities. Due to the temporary nature of the burning, and the projected small amount of material to be burned, these activities would not significantly affect air quality.

Operation Activities. Operation of the HAARP facility at Clear would require the services of 4 to 8 full time staff from the immediate area. In addition, there would be 4 to 5 yearly campaigns which include teams of about 15 scientists and technicians. Pollutants would be generated from commuter vehicles, work vehicles and utility trucks. Due to the limited number of on-site staff and the short duration, episodic nature of the scientific campaigns, the daily increase in vehicle traffic and air pollution would be minimal. Estimates of vehicle use associated with HAARP operation include 3 to 5 vehicles used on a permanent basis, and a maximum 15 additional used for about 28 days during the 4 or 5 yearly scientific campaigns.

Power to operate the HAARP facility will be obtained from the existing (possibly modified or expanded) coal-fired powerplant at Clear AFS and/or the local commercial utility. An evaluation of the approaches for obtaining power would be completed if it was determined to build the HAARP at Clear AFS. The Clear AFS existing plant may currently have the ability to absorb some increased loading from the HAARP facility. Likewise, it is assumed that the local commercial source currently has the ability to provide for the HAARP needs during IRI operation. The small amount of energy required for the day-to-day operations at the HAARP

facility would probably pose no problem to either the Clear AFS powerplant or local commercial utility. Small amounts of power would be required at the Bear Creek location to operate the ISR and VIS units. Most likely, this power would be obtained from the local commercial source. Because both the plant at Clear AFS and commercial power utilility's generation stations are already in operation, there would be little increased pollutants released into the air as a result of the small long-term maintenance loading, or the large short-term experimental loading. The existing Clear AFS powerplant is operating within all applicable air quality standards and guidelines, and would continue to do so with the HAARP facility in place. Increased pollution associated with using commercial power at the Bear Creek location would be undetectable.

Mitigation. Air pollution from operational activities would be mitigated by using thermally efficient building envelopes, energy efficient lighting systems, and promoting intelligent use of energy resources. The air pollution generated by the powerplant meets all applicable criteria and regulations, and it is believed that the increased loading from HAARP will not change this. The government will continue to ensure that appropriate regulatory standards are met at Clear AFS.

4.7.3 No Action Alternative

There would be no air quality impact associated with the no action alternative at the Clear Site. The impacts of the no action alternative on air quality at the Gakona site would be limited to construction operations associated with the required near-term reclamation effort. This source of pollution during construction would be internal combustion engines in construction vehicles and equipment and fugitive dust associated with site reclamation. Other less substantive sources would be temporary electricity generators and open burning.

The exact level of activity associated with the reclamation plan at the Gakona site is not yet known, but in a qualitative sense the level of activity for demolition would be less than for construction. No gravel would be removed from the site, and thus there would be no haul trips or other associated pollution generating activities associated with mining and importing gravel.

The extent of pollution from the construction activities would be not only dependent on the scope of the effort, but also on the type of equipment being used and its relative mechanical condition. Information at this level of detail would not be known until a contractor is selected for the work and a construction reclamation plan is submitted.

Fugitive dust could be generated during removal of the culverts from the road and the demolition of building superstructure and extraction of the concrete footings and sub-floor cooling system from the gravel pad. However, due to the rather limited amount of earthwork that would be conducted as part of the reclamation effort, fugitive dust would not be a significant problem.

Pollutants from other mobil sources during construction could include commuting vehicles used by the construction workers. It is anticipated that all of the workers participating in the reclamation effort would commute to the site from areas within 30 miles of the site. No construction camp is envisioned to achieve the reclamation effort, as surrounding communities would be drawn on to supply the required workers.

On-site burning of combustible construction wastes is being considered as an option for solid waste disposal. If on-site open burning is conducted, the Air Force or its contractors will obtain all required permits.

4.8 SOCIOECONOMICS

4.8.1 Gakona Site

The implementation of plans to build and operate the HAARP facility at the candidate site in Gakona would result in a modest positive impact to the economy in the Copper River region. The opportunities created by the two-year construction period would be temporary, but would both directly and indirectly benefit a number of local residents. The operational phase would have a more modest impact, but would provide an influx of funds for the 20-year project life span. The following section evaluates projected labor requirements and the effect of construction and operation of the HAARP facility as it relates to land ownership, population, economy, housing, community services, and aircraft operations in the adjacent Copper Valley region.

As described in Section 3.8, the local economy has experienced sporadic increases in wage income opportunities associated with activities such as mining and construction (e.g., highways and the Trans-Alaska Pipeline). Hence, construction of the HAARP facility would not represent a new or unique impact to the local population and economy, but another in a series of short-term increases in the economic base.

Land Ownership Issues. There is no requirement for purchasing or otherwise acquiring private or public land at the Gakona site. Therefore, no consequences or mitigation is required in this regard at the Gakona site.

Projected Labor Requirements. The construction of the proposed facility is anticipated to occur between 1993 and 1995. Three construction phases are envisioned. During the first phase of construction, between the fall of 1993 and the spring of 1994, an estimated 60 to 65 workers would be involved in site preparation and gravel operations. Estimates of gravel requirements indicate that up to 7300 haul trips would be required, thus a majority of these positions would consist of truck drivers. Additional requirements could include equipment operators for gravel mining and placement, surveyors, and supervisors.

During the second phase, between the spring of 1994 and early 1995, an estimated 50 workers would be engaged in the remaining gravel operations, placement of piles, building construction, and electrical work. The third phase, extending from the middle to late 1995, would consist of the installation and testing of electronics and communications systems. This phase would employ between 30 and 35 workers.

During the operation of the facility, a full time staff of 4 to 8 people would be required to fill technical support, maintenance, and security positions. During the estimated 28 day long research campaigns, an influx of about 15 scientists and technicians would occur. An estimated 4 to 5 campaigns would occur each year.

Population. Local or regional labor could comprise up to 90 percent of the 60 to 65 positions during the first year, about 50 percent during the second construction phase, and 33 percent during the final installation phase. Given these projections, an estimated maximum of 40 temporary workers would be expected to come from outside the region. Although the temporary nature of the work may limit the number of dependents who might accompany these workers into the area; the peak total number of immigrants during construction should be less than 80 people.

A human resources and services inventory, conducted by Copper River Native Association-Tanacross Impact Services in 1988 for the OTH-B project, indicated that over 400 Copper River Region respondents were interested in employment by the OTH-B program (CRNA-TIS, 1989). The breakdown by employment category indicated approximately 20 percent interest in each of the following categories: construction, operations, maintenance, and security. The status of the interested labor pool has likely remained the same since the survey due to the lack of significant new employment opportunities in the region. Although the hiring practices of the project's contractors would determine the distribution of available jobs, it is expected that the HAARP project would make use of this labor pool.

Housing. The increased demand on housing is expected to be modest since a large percentage of the projected work force would be local or regional residents. Any increased demand for housing would be a result of the potential relocation of regional workers closer to the project and a temporary labor force brought in to meet technical requirements. Some of the potential demand for housing would be satisfied by vacant rental properties, the potential rental of seasonally vacant properties and hotel accommodations.

Housing data from the 1990 census indicated that 80 units were vacant in the surrounding communities of Chistochina, Gakona, Gulkana, and Glennallen at the time of the census. Of the vacancies included in the 1990 census, roughly 10 percent were rental properties and 25 percent seasonal vacancies. The additional availability of hotel accommodations in Glennallen and Gakona Junction, which could accommodate the influx of personnel during research campaigns, indicates that available housing should satisfy housing demands associated with construction and operation of the facility.

Economy. Significant positive economic impacts resulting from the project would be associated with the construction phase. As stated earlier, the distribution of project funds would be determined by the selection of individual contractors and their individual hiring practices. Local and regional businesses would benefit from the purchase of materials as well as the personal expenditures of resident and non-resident workers for a variety of needs.

Economic benefits during the operational phase would be of a lesser magnitude but nonetheless significant given the limited opportunities in the region. The greatest extent of this benefit would be to the individuals who comprise the operational and maintenance staff, as well as those in existing service industries who may be contracted for operational support. These include disposal operations for wastewater and solid waste, fuel supply and delivery, food services and grocery supplies, and other such services. Lodging services would benefit from the influx of personnel during the research campaigns.

Other considerations of economic impacts include the potential impact of increased disposable income on subsistence practices in the region. These considerations are discussed in Section 4.10.

Community Services. Fire suppression response from the surrounding communities is not available to the site. Emergency medical service is available to the proposed HAARP site. The addition of the proposed facility is considered to have a negligible affect to emergency medical service (M&E/H&N, 1992c).

Aircraft Operational and Airspace Issues. There are two areas where possible interference may occur to commercial, private or military aircraft. First is a possible physical obstruction and second is interference to aircraft communication or navigation instruments (referred to as avionics). Since the maximum height of the proposed facilities would be about 100 feet, aircraft use would not be affected. The potential interference to aircraft avionics include the following instruments: a global positioning system, VHF radio, UHF radio, VHF omni-range (VOR) receiver, LORAN, and automatic directional finder (ADF). Operation of the IRI and ISR, either separately or simultaneously, could result in some potential hazards to aircraft avionics. This potential impact is due to the separate emissions of each. The VIS would not have an impact to aircraft avionics due to its low operational power. A detailed discussions about these instruments and potential interference can be found in Section 4.14 Electromagnetic and Radio Frequency Interference. In coordination with the FAA, pilots will be warned to avoid flying within 9,000 feet of the IRI and ISR and below an altitude of 16,000 feet (MITRE, 1992f). This suggests a single warning area could be established that would protect against potential HAARP hazards to flight. HAARP will employ an aircraft detection and tracking radar. When this radar detects aircraft on a track that would carry them through the warning area, the radar will automatically turn off the appropriate HAARP emitters.

Because there are no airfields or airstrips close, to the site aircraft take-offs and landings would not be affected. Although the Gakona site is located on the edge of a Federal Aviation Administration (FAA) designated instrument flight corridor, the IRI system would be designed

to detect approaching aircraft and automatically turn the appropriate emitters off. The direct impact to commercial, private and military aircraft would not be significant.

Mitigation. Utilization of the local labor pool could minimize any increase in the permanent regional population and benefit the regional economy at the same time. Fire supression response from the area communities is not available. Fire prevention, protection, detection and suppression systems for the HAARP facility would be designed accordingly. Properly trained full-time facility employees on fire supression techniques could help address emergencies. On-site vehicles could be equiped with firefighting equipment and emergency medical kits. The town of Glennallen could be approached by the government to discusss the possibility of extending coverage to the site. Appropriate warnings to pilots, in coordination with the FAA, will be provided to avoid potential HAARP hazards to flight. The IRI system is designed to detect approaching aircraft and shut itself off in such instances. No other mitigation would be necessary for location of the HAARP facility at the Gakona site.

4.8.2 Clear Site

Below is a discussion of the consequences of selecting the Clear site, and possible mitigation efforts that could be implemented. A discussion of the reclamation effort is required at Gakona and its consequences and mitigation as it relates to socioeconomics is included under Section 4.8.3 No Action Alternative.

The construction of the proposed HAARP facility at the Clear Site would result in a small positive impact to the economies in the surrounding area. The opportunities created by the three-year construction period would be temporary, but would both directly and indirectly benefit a number of local residents. The operational phase would have a more modest impact, but would provide an influx of funds for the 20-year project life span. A consequence of building the HAARP facility at the Clear site would be the required reclamation of the existing powerplant building and gravel pad, as well as extraction of drainage culverts and scarifying of the gravel access road.

The following section evaluates projected labor requirements and the effect of construction and operation of the HAARP facility as it relates to land ownership, population, economy, housing, community services, and aircraft operations in the Clear Region.

Land Ownership Issues. Land at the Clear AFS property is owned by the Air Force and additional land acquisition in this area is not necessary at this time. There is a requirement to purchase land for the Bear Creek location of the ISR and VIS units. The impacts of locating these diagnostics at this location include disrupting existing homesteading activities and precluding further homesteading in the area. Disruption of existing activities could include selling the homesteading parcels, or portions of parcels, to the Air Force to provide enough land to construct the ISR and VIS facilities. Additional impacts could include aesthetic impacts on adjacent landowners as a result of the constructed facility and increased noise and traffic in the area, thereby detracting from the rural homesteading environment.

The final impact could be displaced homesteaders that purchase or homestead land in a different area, as a result of a buy-out by the Air Force. Land of similar quality to the land at Bear Creek and with the same population density could be difficult to find in the Nenana River Valley. The Bear Creek location is accessible from major Alaskan Highway and has commercial electrical power readily accessible by overhead power lines.

The primary impact of using state land for HAARP that is designated as a primary use of "settlement" would be the preclusion of further homesteading in the immediate area. Although Alaska is a large state, road accessible homesteading land is not plentiful. Homesteaders not wishing to leave the Nenana River Valley area may have difficulty finding land of similar quality as that at Bear Creek (ADNR, 1991a). In addition, the large dish antenna and several antenna arrays that comprise the Bear Creek location site may add a "developed" look to the valley that is not appealing to the homesteaders visual ideals. This could further preclude homesteading in the area by affecting a much larger area than the actual Bear Creek location. Again, homesteaders displaced from the Bear Creek location may have difficulty finding the same quality property at another location, resulting in possible "over-crowding" in other areas.

Population. The labor force from the surrounding communities of Anderson, Ferry, Nenana, and Healy would be used for the construction work with the exception of some specialized labor needs toward the end of the construction effort. These specialized laborers would represent 8 to 10 of the 30 to 35 people working on the construction effort at that time.

Housing. The demand on housing would be almost nonexistent since the majority of the projected work force would be from the surrounding communities. Any increased demand for housing would be a result of the temporary 8 to 10 specialists brought toward the end of the construction effort. Any potential demand for housing could be satisfied by accommodations at Clear AFS, by vacant rental properties (Table 3.8-6), or the rental of seasonally vacant properties, hotels, and bed and breakfast accommodations.

Economy. Significant positive economic impacts resulting from the project would be associated with the construction phase. As stated earlier, the distribution of project funds would be determined by the selection of individual contractors and their individual hiring practices. Businesses in the four surrounding communities would benefit from the purchase of materials as well as the personal expenditures of the small contingent of non-resident workers and research personnel for a variety of needs. Economic benefits during the operational phase would be negligible. The greatest extent of this benefit would be to the individuals who comprise the operational and maintenance staff. Lodging services would benefit from the influx of personnel during the research campaigns.

Community Services. Emergency medical services and firefighting capability could be provided to the HAARP facilities by Clear AFS emergency response services. There would be negligible affect to the surrounding towns emergency services. Clear AFS envisions minimal impact to their existing emergency response operations (M&E/H&M, 1992e).

Aircraft Operational and Airspace Concerns. Impacts on aircraft operations at the Clear/Anderson airstrip should not be affected by the construction or operation of the HAARP facility. The existence of the proposed 75 foot high IRI antenna masts located approximately

3300 feet from the end of the runway does not interfere with the FAA geometric criteria as laid out in Advisory Circular 150/5300-13.

Restrictions on the use of the Clear/Anderson airstrip are already in place, due to the airstrips proximity to the high powered BMEWS system at Clear AFS. NOAA's Airport Facility Directory, Alaska Supplement, states that the runway is unattended, and visual inspection is recommended prior to use. Restricted airspace and special traffic patterns are in-place for landing and take-offs. Additional restrictions on aircraft operations at the airstrip would not be necessary as a result of the HAARP facilities being located at the Clear site. The IRI system is designed to detect approaching aircraft and shut itself off when this occurs. Departing aircraft's navigational instruments would not be affected because pilots would not be using them until after take-off and when they were out of the IRI beam. The potential for interference to aircraft avionics at the Clear site is similar to those at the Gakona site. Operation of the IRI and ISR, either separately or simultaneously, could result in some potential hazards to aircraft avionics. This potential impact is due to the separate emmissions of each. The continuous transmission of the BMEWS radar does not change this conclusion. The VIS would not have an impact to aircraft avionics due to its low operational power. A detailed discussions about these instruments and potential interference can be found in Section 4.14 Electromagnetic and Radio Frequency Interference. In coordination with the FAA, pilots will be warned to avoid flying within 9,000 feet of the IRI and below an altitude of 16,000 feet above the IRI (MITRE, 1992f). In addition, pilots will be warned to avoid flying within 2,500 feet of the ISR and below an altitude of 4,000 feet above the ISR (MITRE, 1993a). This suggests two warning areas (one for the IRI and one for the ISR) could be established that would protect against potential HAARP hazards to flight.

Military exercises in MOA's and TMOA's may increase traffic in the Clear area as aircraft are routed through airways between the Nenana and Talkeetna VOR's. The HAARP facilities would not affect air traffic because the IRI system is designed to detect encroaching aircraft and shut itself off in such instances.

Mitigation. The layout of the ISR and VIS units at the Bear Creek location is based solely on HAARP operational concerns. As currently shown, the Bear Creek equipment directly affects about four homesteaders (Figure 3.1-1). Through relocation of the equipment and the access road, the site layout would be modified to minimize overlap with any of the current claims. Appropriate warnings to pilots, in coordination with the FAA, will be provided to avoid potential HAARP hazards to flight. The IRI system is designed to detect approaching aircraft and shut itself off in such instances.

4.8.3 No Action Alternative

There would be no impact at the Clear site associated with the no action alternative. No action would require the near-term reclamation of the Gakona site. Reclamation of the site would take approximately one year.

The no action alternative would have a small, brief, positive impact on the Gakona area economies. The reclamation effort at the Gakona site would include the demolition of the powerplant and the excavation and extraction of the concrete foundation and sub-floor refrigeration. Upon removal of the building system, the top 3-4 feet of the building's gravel pad would be stripped away, leaving the remaining gravel pad approximately the same thickness as the existing gravel road. Reclamation efforts on the road would include scarifying the surface to induce natural revegetation, and excavation and removal of the existing culverts. It is estimated that this work would require a construction crew of approximately 10 to 12 working for one summer season. Among the workers involved in the reclamation effort would be truck and heavy equipment operators, iron workers, construction supervisors, and environmental monitors. The socioeconomic impact on the region of this relatively small construction project would be minimal. Many of the workers used for the reclamation effort would most likely be hired from the local labor pool, thus further minimizing socioeconomic effects. Any small impact in this regard could be further mitigated by encouraging the reclamation contractor to utilize local area labor.

Without the construction and operation of the IRI and diagnostics there would be no consequences to aircraft operations or air-space concerns at the Gakona site. Mitigating measures would not be required for aircraft for the no action alternative.

4.9 CULTURAL RESOURCES

This section discusses the potential impacts on cultural resources associated with the construction and operation of the HAARP facility at either site and the no action alternative. Mitigation associated with these potential impacts is also presented. The impacts of constructing at the Gakona site and the no action alternative would be negligible. The likelihood of uncovering cultural resources at the Clear site would be high, and significant impacts could occur.

4.9.1 Gakona Site

This section evaluates the potential impacts to cultural resources that may result from construction and operation of the HAARP facility at the Gakona site. The following impact assessment is based in part upon studies identified in Section 3.9.2 which were previously conducted at the Gakona site (Ahtna Tanacross Association 1989; AEIDC, 1989b; AEIDC, 1991; Gerlach et al., 1990), and in part on the potential for cultural resources to exist, based on land use patterns.

Potential Impacts from Site Construction. The areas in which cultural resources could be affected by construction of the HAARP facility include the transmitter area, operational buildings, diagnostic equipment sites, access roads and the area selected for gravel mining, including the corridor that might be used for hauling of material to the site. Based on the previous archeological investigations conducted in association with the OTH-B program, indicated above, which encompassed the area considered for HAARP transmitter construction, no impacts to existing cultural resources would likely result from construction of the IRI and on-site diagnostic equipment. This conclusion takes into consideration the recommendation for OTH-B from the Alaska State Historic Preservation Officer (SHPO) that archeological monitoring would not be necessary for OTH-B construction due to the low probability of encountering cultural resources (Section 3.9.2.1).

Portions of the proposed access road to be constructed north of the transmitter array to access the diagnostics (see Figure 2.1-1) are outside of the OTH-B cultural resource surveys. Based on the similarity in landscape and habitat type to areas encompassed by the prior surveys, it is expected that significant cultural resources would not be encountered during construction of the access road extension.

Gravel removal from the any of the identified resource areas has greater potential for impact to cultural resources due to the proximity of the gravel areas to the Copper River. This proximity increases the possibility that cultural resources exist due to subsistence activities traditionally practiced near the river (refer to Sections 3.9 and 3.10). Numerous cultural sites were uncovered during intensive archeological investigations of area P-1 (Section 3.9.2.2). These were predominately found associated with trails along the river terrace and in areas adjacent to present and historic river banks. Although the other gravel areas were not subjected to the same degree of investigation as P-1, the probability of encountering cultural resources in the other gravel area would be similar to area P-1.

Mitigation. Due to the fact that some proposed construction areas at the HAARP site would be outside of previous cultural resource survey areas, the government would enter into a programmatic agreement with the Alaska SHPO to prevent loss of cultural resources. The programmatic agreement would document the process by which the Air Force would comply with Section 106 of the National Historic Preservation Act (36 CFR 800.4).

The gravel removal plans developed for utilization of area P-1 for gravel requirements of the OTH-B program (Moolin & Associates, 1990a) were determined by archeologists to be sufficiently protective of the known cultural resources in the river floodplain and adjacent terrace (AEIDC, 1991). Monitoring of certain sections of the area which were close to mining and transportation areas was recommended by the SHPO. The relatively low gravel requirements of the HAARP design alternatives compared to that of the OTH-B program would permit a greater degree of protection to known cultural sites through utilization of sufficient buffer area

between operations and known resources. Inadvertant discoveries would result in temporary work stoppage until the site could be evaluated.

4.9.2 Clear Site

Below is a discussion of the consequences of selecting the Clear site, and possible mitigation efforts that could be implemented. A discussion of the required near-term reclamation effort required at Gakona and its consequences and mitigation as it relates to cultural resources is included under section 4.9.3 No Action Alternative.

This section evaluates and describes the potential impacts that construction of the HAARP facility would have on cultural resources in the Clear area. Moreover, possible mitigative action is described to limit impact on area cultural resources by the proposed action.

Potential Impacts from Site Construction. Construction of the HAARP facility would affect about 78 total acres of land, with about 37 being the Bear Creek location, and about 41 being at the Clear AFS property. Construction on this land would involve stripping away top layers of rootmat and silty loess materials, to expose the gravel and sand outwash below. The depth of this top layer to be removed will be between 1 and 6 feet thick. It is during this construction activity that the major disruption to the ground would occur and thus, there is the greatest possibility for archeological finds.

At the Clear AFS property, the siting of the IRI, the LIDAR, and the optics and magnetometer would be located in an archaeologically rich region known as the Healy Outwash Terrace. According to a cultural resources survey of Clear AFS (Braid, 1991), there is a high probability of cultural resource sites being located in this region. This conclusion is based on a site survey and historical finds in the region throughout the Nenana River Valley.

Due to the proximity of the Bear Creek location to the Nenana River and other past cultural resource sites, there would be a high probability of discovery in this region as well. Therefore,

during construction in each of these two areas (Bear Creek location and Clear AFS property) there is the potential for disrupting archeological and cultural resource sites.

It is anticipated that the small quantity of gravel required to build the HAARP facility at the Clear site will be obtained from existing borrow pit locations. Thus, the disruption to the soil layer that would contain the archeological sites has largely already occurred. However, some bank sloughing associated with gravel mining could occur, and therefore there would be a potential for discovery of cultural resource sites in connection with obtaining gravel material.

Impacts on the two NRHP sites (FAI 010 Clear Townsite and FAI 342 White Alice Communication System) in the Clear Area would be minimal. In fact, for FAI 010 there would be no impact, and for FAI 342 the impact from the construction of the HAARP facility would be limited to visual effects from the top of the antenna tower. Note that these effects would be limited to observations from up on the tower assembly, which is currently the property of Alascom. General access to this tower is not permitted and is limited to Alascom employees that are servicing the relay station. Furthermore, the viewer sensitivity to the relatively small HAARP equipment when compared to the massive existing BMEWS antennas would be insignificant.

Mitigation. To avoid significant impacts to cultural resources during construction of the HAARP facility several measures could be taken. Prior to construction the government would coordinate with the Alaska SHPO. A detailed cultural resources survey of the specific areas to be impacted by the construction of the HAARP facility could be conducted. This survey could include subsurface investigations to better be able to predict the potential for cultural resource sites in the area. Other mitigative measures would include archeological monitoring during construction of the facility. If an inadvertent discovery is made, construction would stop and the SHPO will be contacted to avoid risk of further disturbance.

4.9.3 No Action Alternative

There would be no impact on cultural resources at the Clear site associated with the no action alternative. This section discusses the impacts at the Gakona site on cultural resources associated with the no action alternative. The required near-term reclamation plan for the Gakona site calls for excavations to be limited to areas containing gravel fill that have been established within the last two years. All construction efforts, including the demolition of the powerplant building and the extraction of the culverts from the recently constructed roadway, would involve only the disturbance of fill gravels. There would be negligible disturbance to soils, and therefore the likelihood of disturbing cultural resource sites would be non-existent.

4.10 SUBSISTENCE

No significant long-term impacts to subsistence, terrestrial animals, fish, and vegetation would occur as a result of the construction and operation of the HAARP facility. However, short term impacts to salmon and other aquatic species may result at borrow pit P-1 at the Gakona site, if this borrow pit was to be used.

The following section discusses potential impacts on subsistence which may result from construction and operation of the two alternative sites for the proposed facility. Subsistence activities may be affected by direct or indirect impacts to subsistence species. Subsistence species distribution can be affected by loss of access to areas traditionally used for subsistence activities. The abundance of subsistence species can be affected by factors such as shifts in population or economics which may alter competition for subsistence resources or the pursuit of subsistence activities.

The assessment of potential impacts to subsistence is consistent with the requirements of Section 810(a) of ANILCA (16 U.S.C. §3120), which calls for a determination of whether the proposed action will result in a significant restriction of subsistence uses. A significant restriction is defined as: 1) a reduction in harvestable resources due to effects on the resources, habitat, or increased competition for the resources, 2) a reduction in the availability of resources caused by an alteration in their distribution, migration, or location, or 3) a limitation on the access of subsistence users to harvestable resources as a result of physical or legal barriers. Large or substantial effects in one or more of these categories would result in a Section 810(a) finding of significant restriction of subsistence uses and needs. As supported below, there would be no significant restriction to any of the Section 810 subsistence categories for either of the three alternatives; the Gakona site, the Clear site, or No Action.

4.10.1 Gakona Site

Direct and Indirect Impacts to Subsistence Species. Based on the information presented in Section 3.10 regarding subsistence use patterns in the area, potential impacts to moose, caribou, and salmon are considered critical to the evaluation of the proposed project's impacts on subsistence. Additional subsistence considerations include game birds such as grouse and ptarmigan, small game and furbearers, freshwater fish species, and vegetation such as berries, mushrooms, wild vegetables, and trees used for firewood.

The potential impacts to mammals and birds which may occur during construction and operation of the facility are discussed in Sections 4.3 and 4.4, respectively. Both short-term and long-term impacts to populations are considered. These include pre-operational impacts associated with clearing, gravel mining and hauling, and facility construction, as well as impacts associated with operation and servicing of the facility. Potential impacts to fish and other aquatic resources are discussed in Section 4.5. These are primarily associated with gravel removal in areas adjacent to aquatic resources such as Tulsona Creek and the Copper River. Operational impacts would be negligible due to the lack of aquatic resources in proximity to the facility and the absence of any surface discharge from the facility. Impacts to vegetation are discussed in Section 4-2.

The conclusions reached in Sections 4.3 and 4.4 indicate no significant long-term impacts to population abundance of important subsistence species would occur due to the implementation of the design scheme. No significant long-term departure from normal distributional patterns would be anticipated. Only limited loss of habitat will occur due to exclusion by the fencing the perimeters of the IRI and on-site diagnotic equipment. Some short-term avoidance behavior may occur during construction which may result in reduced hunting success in the immediate area of the facility. This short-term effect on distribution will not be of a sufficient magnitude to result in significant impacts to successful subsistence harvests.

The discussion of impacts to salmon and other aquatic species in Section 4.5 concluded that short-term impacts may result at Area P-1 under scenarios where gravel removal requires

diversion of Tulsona Creek. No long-term impacts are foreseen under either design alternative. The proposed creation of aquatic habitat during restoration of gravel resource areas will be a positive impact.

Based on these determinations, potential direct or indirect impacts to subsistence species would not significantly impact subsistence activities related to terrestrial animals and fish species. Although, assessments of impacts to vegetation in Section 4.2 indicated no significant impact to plant populations would result from construction or operation of the facility, loss of access to limited plant resources within the facility boundaries would occur.

Loss of Access for Subsistence Activities. Construction of the HAARP facility at the Gakona would result in the loss of access to land. The maximum amount of land precluded from subsistence access would be about 50 acres. The government does not anticipate any change in current use of the site outside of the fenced-in areas. While this acreage may include some areas of preference for individual subsistence users, the habitat type is typical of the area and contains no exceptional characteristics which would offer unique subsistence opportunities. No aquatic habitats supporting subsistence species are found within the facility area. The restricted access thus does not represent loss of prime habitat areas which would significantly affect subsistence activities for important species such as moose, caribou, and salmon. Access to resident populations of small game, birds, and vegetation within this area would be insignificant relative to the large acreage of similar habitat surrounding the facility.

Other Factors Influencing Subsistence Practices. Other factors which could affect subsistence practices in the region include an influx in population which might result from job opportunities created by construction and operation of the facility, and an increase in disposable income resulting from the additional wage employment. Hiring practices would likely include the hiring of local Natives, which would tend to minimize the influx of workers and dependents. This in turn would minimize any short-term increase in competition for subsistence resources during the construction phase of the project. Avoidance of significant numbers of in-migrants pursuing game would minimize an increase in hunting practices perceived by Natives as offensive to the

animals, preserving the traditional respect extended to these animals and ensuring their return the following season.

Staffing requirements during the operational period would be minimal, consisting of security personnel and facilities maintenance staff. In all likelihood, the majority of these positions would be filled by local residents, thus little impact from population influx is foreseen. The transient nature of research personnel utilizing the facility would preclude additional demand on subsistence resources from this group.

The increase in disposable income realized by local residents who become employed by the HAARP project could affect subsistence activities in diverse ways. Individuals employed by the project, either on a full-time or part-time basis, would have less time available to pursue the harvest of subsistence resources. On the other hand, a portion of the increased disposable income frequently is used to purchase "subsistence technologies" such as hunting gear (Section 3.10.4). These items offer increased efficiency in harvest activities, which may offset the reduced time available to individuals to pursue subsistence resources. Those employees with dependents capable of hunting would benefit from the increased harvest efficiency of their dependents. Increased income could also lessen the need for dependency on subsistence resources because the individual may be able to afford to purchase goods.

Mitigation. Based on these conclusions of no large or substantial effects in any of the categories of Section 810, a finding of no significant restriction on subsistence uses and needs is anticipated. Thus, no mitigation would be required for impacts to subsistence.

If gravel were to be obtained from source P-1 during construction, containment berms would be used to minimize water quality impacts to Tulsona Creek and the Copper River from turbidity due to erosion. Maintenance of a 100-yard buffer area would further minimize any potential water quality impacts which might be detrimental to subsistence fishing success. The construction and operation of the HAARP facility would utilize local labor resources to the

greatest extent possible to limit the importation of labor and the competition it brings for subsistence and recreational resources.

4.10.2 Clear Site

Below is a discussion of the consequences of selecting the Clear site, and possible mitigation efforts that could be implemented. A discussion of the required near-term reclamation effort required at Gakona and its consequences and mitigation as it relates to subsistence is included under section 4.10.3 No Action Alternative.

Direct and Indirect Impacts to Subsistence Species. Based on the discussion of subsistence use patterns in the Clear area (see Section 3.10), impacts to moose and caribou harvesting are among the most important. Other subsistence harvesting carried out in the region include fish (salmon and non-salmon species), birds, other large and small game, and wild vegetation and wood gathering.

The consequences to mammals and birds associated with constructing HAARP are discussed in section 4.3 and 4.4, respectively. Short- and long-term impacts on species populations are considered, relating to both construction and operation of the facility at the Clear site. Impacts to fish and aquatic life are discussed in section 4.5.

The conclusions developed in the aforementioned sections are that there would be no significant long-term impact to mammals, birds, or fish population abundance in the Clear region. In addition, it was concluded that no departure from normal behavior or population distribution patterns would be brought about by the construction or operation of the HAARP facility. Long term minor impacts on mammals and birds may include increased mortality brought about by sport hunting, poaching, and road kill, but these contributions would be minimal considering the relatively small amount of personnel and activity associated with the operation of HAARP.

Limited loss of habitat and browse would not affect wildlife populations. Since few caribou use these areas minimal impact to this species is anticipated. Due to the large range of wolves and bears there is no direct impact on these species. Some short-term mammalian and bird avoidance behavior would result from the construction and operation of the HAARP facility. This could result in reduced hunting success in the very immediate HAARP equipment areas. However, this very localized effect would not be sufficient to significantly change subsistence harvests in the region.

Section 4.5, Aquatics, concludes that the impacts on the salmon and non-salmon fisheries in the region would be minimal to non-existent. This would primarily be due to the positioning of the construction sites relative to surface water sources, and the absence of a large salmon or non-salmon fisheries in the immediate region. Any short term impacts would be associated with increased sport fishing activity brought about by an influx of construction workers.

Impacts on vegetation are discussed in Section 4.2. The assessment in this section concludes that there would not be a significant impact on vegetation at the site, and that the specific siting would be done to limit, to the greatest extent practical, the destruction of herbaceous plants commonly used for subsistence purposes.

Based on the determinations outlined above, it is concluded that the potential direct and indirect impact of HAARP construction and operation on subsistence species and resources would be insignificant. No mitigation in this regard is required or is seen to be helpful.

Loss of Access for Subsistence Activities. The HAARP site at Clear would occupy an area of about 78 acres. While the Clear AFS property and the Bear Creek location contain some areas that have been used for subsistence activities in the past, the areas are not unique from a habitat or subsistence opportunity perspective. No subsistence fishery is known to exist in the facility area, either at the Bear Creek location or the Clear AFS property. The restricted access areas thus would not result in the loss of prime habitat for important subsistence resources such as moose and caribou. Access to other subsistence resources such as game birds, other large and

small mammals, and subsistence vegetation is virtually unlimited in this massive region, and the loss of about 78 acres would not be a significant impact to subsistence.

Other Factors Influencing Subsistence Practices. Other factors which might impact on the subsistence quality of the region include an influx of population to the area associated with the construction and operation of the HAARP facility. A large population change for the immediate area could increase the number of local subsistence users, and also yield more recreational hunting and fishing activities which would compete for resources with subsistence activities. Another potential concern is that the disposable income of some individuals employed by the HAARP project could increase, thereby increasing their ability to purchase weapons, vehicles, and tools which increase the efficiency of subsistence harvesting.

The policy of the construction contractor is to utilize local labor resources to the greatest extent possible, thereby eliminating a large influx of construction workers and their families and dependents. This policy would minimize any short-term increase in competition for subsistence resources. It would also help avoid significant numbers of workers from outside the region taking fish and game in the area in a manner that is considered disrespectful and offensive to nature in the eyes of Alaskan Natives.

Full-time staffing requirements of the HAARP facility would require 4 to 8 people. These positions would likely be filled from the local labor pool. Again, this would limit the amount of worker influx that could impact the availability of subsistence resources.

The increase in local income by some individuals as a result of the addition of the HAARP facility to this region could impact subsistence activities in diverse ways. Individuals working at the HAARP facility on a full-time basis may have less time to pursue a subsistence lifestyle. However, it can be argued that the increase in income would allow these individuals to purchase "subsistence technologies" (i.e. vehicles, firearms, and tools) that increase their efficiency of harvesting fish and game, which may help offset the decreased time available. Family members and dependents of HAARP employed personnel may benefit from the "subsistence technologies"

which would increase their efficiency without the decrease in time associated with working at the HAARP facility. Increased income could also lessen the need for dependency on subsistence resources because the individual may be able to afford to purchase goods.

Mitigation. Based on the discussion above, it is concluded that no large or substantial effects in any of the categories in Section 810 would occur. Therefore, no significant restriction on subsistence uses and needs would occur and no mitigation would be required.

As discussed above, the construction and operation of the HAARP facility could utilize local labor resources to the greatest extent possible to limit the importation of labor and the competition it brings for subsistence and recreational resources. Mitigation associated with the preservation of subsistence species and resources is described in detail in Sections 4.2 Vegetation, 4.3 Mammals, 4.4 Birds, and 4.5 Aquatics.

4.10.3 No Action Alternative

There would be no impact on subsistence at the Clear site associated with the no action alternative. The no action alternative would result in slight impacts at the Gakona site due to the required near-term reclamation. The potential impacts to vegetation, mammals, fish and birds at the Gakona site as a result the reclamation is presented in Sections 4.2 through 4.5.

Short-term impacts associated with the reclamation effort could include some avoidance behavior of mammals and birds as a result of the increased level of man's activity in the immediate area. However, the short-term affect on the population distribution of the birds and mammals would not be significant to subsistence harvesting.

Impacts to salmon and other aquatic species as a result of the reclamation effort would be non-existent. Similarly, there would be no impact on existing vegetation as a result of the no action/ reclamation effort at the Gakona site.

Loss of access for subsistence activities in the immediate area may occur in the short-term as a result of the no action and associated reclamation effort at the Gakona site. Although no detailed plan has been presented on the construction of the reclamation activity, it is estimated that this effort would last on the order of one year, at which time the site would be formerly abandoned. Note that the area around the existing Gakona site is typical of the habitat type in the area, and no exceptional characteristics are present at the site which would offer unique subsistence opportunities.

The long term effects of the no action alternative at the Gakona site could include an actual enhancement of the site for subsistence harvesting of large game. Eventually, the gravel pad and roadway would return to uplands vegetation growth; well suited for moose browse areas. The roadway, even in its reclaimed state (culverts removed and gravel scarified) could provide improved access to the area via off-road-vehicles. Additional affects could include the increased harvesting ability caused by using the cleared areas at the site for hunting corridors, thus permitting greater hunter surveillance of the area and increased harvest rates.

Other factors brought about by the no action and associated reclamation effort involve the potential influx of construction workers who might compete for subsistence resources and temporary increases in disposable income for locals which might increase their ability to harvest game. The construction effort associated with the reclamation effort would be relatively small in scope, and would not bring about an influx in construction workers realized on larger projects. Additionally, it is typically cheaper to utilize existing local labor pools as opposed to importing labor. Thus, impacts relating to increased competition for subsistence resources would not be significant. Similarly, the temporary increase in disposable income for locals who might use this money to purchase "subsistence technologies" would not be significant.

4.11 RECREATION

Construction and operation of the HAARP facility would not significantly reduce recreational opportunities for Alaska residents or visitors. Mitigation is suggested for each of the alternatives to limit the small amount of impact anticipated.

4.11.1 Gakona Site

Potential Impacts. A BLM trail currently extends through the Gakona site north from the Tok Cut-Off Highway. The trail provides access to BLM lands located north of the site. The government will ensure that access to the these BLM lands north of the site is provided.

The quality of recreational experiences would decline in areas that have direct views of the chosen and utilized borrow site (see Section 4.12 Aesthetics) and would temporarily decline during the construction period due to increased traffic and noise. The approximately 40 non-regional workers at the peak of construction would add to the general increase in resource use that occurs during the winter and summer. However, these nonresident construction employees would be a small fraction of the total visitor count, which is estimated to be 600,000 in the Copper River Valley (USAF, 1989a).

Construction workers hired from outside the local communities may affect recreational visitors in the rural areas. For example, construction workers may choose to occupy public campsites for temporary stays in rural areas. Although they would compete with recreational users, their periods of residence would be limited by restrictions that prevent long-term use of campgrounds.

Construction workers could also compete with local residents and visitors for use of recreational resources, such as trails, fish and game, and wild berries. In the spring, bear and snowshoe hare are hunted; in summer, fishing, berry picking, and target shooting are popular; in the fall, bear, moose, caribou, and grouse are hunted; and in the winter, snowmobilers and trappers are active.

Some fraction of the teams of scientists that would be using the IRI facilities, about 4 to 5 times a year for about 28 days at a time, may hunt and fish in the regions of the Copper River Valley and Tanana Valley. The impact of this activity would be minimal because only roughly 15 scientists would visit the site during each campaign and not all of these would choose to hunt and fish. Impacts to recreational resources during the operation of the IRI would be insignificant.

The preferred site would be located in an expansive black-spruce taiga forest that has no unique features in terms of wildlife habitat and probably only received limited use by hunters. Access to remote public areas to the north via the BLM trail traversing the site would be maintained or an alternate means would be provided. Since, as discussed in Section 4.3, there would not be significant impacts to wildlife, there would be no significant impact on the availability of game to the region's hunters. The lost habitat would be minimal as compared with the total spruce habitat in the area. Therefore, impacts on recreational hunting activity in the immediate area of the site would be minimal.

As discussed in Section 4.12.2, the completed IRI and diagnostic facilities would be a major landscape feature visible from small aircraft. Therefore, there would be an impact on recreational visitors who use small aircraft for transport to backcountry sites and for sightseeing tours from Tok and Gulkana. Those aerial views of the IRI and diagnostic facilities would not detract significantly from the pleasure or value of recreational activity while flying.

Mitigation. Area labor would be used both for the construction of the HAARP facility, as well as for the anticipated 4 to 8 person operations and maintenance crew. Utilization of area labor to the greatest extent possible would mitigate the effects of increased competition for recreational resources that would result from an imported construction force.

Mitigation of the aesthetic effects associated with recreational concerns is discussed in section 4.12. Visual impact and viewer sensitivity would be mitigated through the use of re-vegetation programs and selection of structure color.

4.11.2 Clear Site

Below is a discussion of the consequences of selecting the Clear site, and possible mitigation efforts that could be implemented. The consequences to recreation of the required near-term reclamation effort at the Gakona site is provided in Section 4.11.3 No Action Alternative.

Potential impacts on recreation at the Clear site would include detractions from the natural vistas, particularly at the Bear Creek location. Impacts on recreation at the Clear AFS property is considered to be minimal, while impacts at the Bear Creek location are potentially moderate.

Potential Impacts. Access to 78 acres of land would be lost as a result of the HAARP construction at the Clear site. The Clear AFS property could be considered low in recreational value, while the Bear Creek location could be considered moderately valuable. To hikers, river floaters, sightseers, railroad passengers, and highway motorists the ISR and VIS facilities at Bear Creek could detract from the natural vistas that many come to Alaska to experience. For more on the aesthetics issue, see Section 4.12. Since most of the proposed HAARP facilities would be located on the Clear AFS property, which has controlled access and is relatively low in topographic relief, aesthetic detraction from recreational enjoyment would not be significant.

To protect the ISR unit at the Bear Creek location from radio frequency interference from the BMEWS system at Clear, a large earthen mound (110 feet high) would be constructed to the north of the ISR and VIS equipment (Figure 2.3-6). The Bear Creek location would also have two antenna clusters which comprise the VIS. Naturally occurring trees and vegetation in the area would not be tall enough to provide visual screening. The large antenna and earthen mound at the ISR site would be rather tall and would be visible from the surrounding hills and prominent mountain domes ascended by hikers, but more commonly viewed by train passengers, motorists and river rafters in the area. The presence of this facility in a region that appears otherwise untouched would detract from the "wilderness" setting.

It is anticipated that very few construction workers would need to be imported to the region to complete the construction of HAARP facilities. This also applies to the operation of HAARP facilities. The use of area labor would reduce the recreational impact that could be realized if a large transient construction team were to be used. Recreational impacts that would be avoided by using the local residents include prolonged campsite occupation, and overuse of hiking trails, fishing and hunting resources, and wild vegetation harvesting.

The scientific campaigns would result in the influx of about 15 scientists and technicians to the area for a period of about 28 days, occurring 4 to 5 times per year. Some of the individuals involved in the program may stay on to recreate in the area. However, due to the small number of scientists, and recognizing that not all would participate in recreational activities, the impact from this source would be minimal.

The HAARP facility would be easily visible from small aircraft and could detract from the visual setting. Again, this is particularly true at the Bear Creek location. At the Clear AFS property, the BMEWS antennas and facilities tend to dominate the landscape and would overshadow any visual detraction that the HAARP equipment would provide. Visitors, tourists, and vacationing Alaskan residents often use small aircraft for sightseeing activities and to provide drop-off services to backcountry destinations. Although the HAARP facilities would not detract significantly from the pleasure or value of the recreational experience, there would be some recreational impact associated with aesthetics.

In conclusion, although there would some impacts relating to quality of the experience and visual degradation, these issues could be mitigated. The use of the land for HAARP construction would be within the BLM visual resource management guidelines for Class II/III land.

Mitigation. Mitigation measures identified for the Gakona site would be used at the Clear site. Refer to the above section 4.11.1, Mitigation, for a detailed discussion.

4.11.3 No Action Alternative

There would be no impact to recreation at the Clear site from no action alternative. The required near-term reclamation effort at the Gakona site would result in both short and long-term effects. Short-term effects could include increased pressure on recreational resources such as hunting grounds, fisheries, campgrounds, and tourist hotels due to an influx of construction workers. However, it is anticipated that the construction contractor performing the reclamation project would utilize local labor resources to the maximum extent possible.

Additional impacts on recreation could include noise and increased traffic in the area due to the construction effort. The construction effort, however, is anticipated to be relatively small in scope to the point where noise will not be a problem. In turn, because limited hauling of earthen material off-site would be required, the amount of increased traffic on the road would be limited to commuting activities by the construction workers from their homes in the area to the site. This increased traffic load would be small relative to the overall traffic on the highways.

Hunters and fishermen using the BLM trail to access recreational locations in the area would be impacted in the short term due to visual and acoustic detraction as a result of the construction activities. However, these activities would be short-term and would impact a minimum of users.

There would be several long-term impacts associated with the required near-term reclamation at the Gakona site. The reclaimed roadway could provide access to the BLM trail and adjacent property by ORV's and other equipment. Similarly, the reclaimed site could grow into prime moose and other large game habitat, thereby increasing the site's hunting value. The cleared areas could provide opportunities to the hunter to see game in an otherwise densely vegetated area that yields little hunting success, thereby increasing success rates and its value as a hunting area.

The area would also receive a positive recreational benefit associated with the demolition and removal of the large powerplant building in the long-term, and with the total regrowth of the site to its near natural condition in the long term. This would decrease the aesthetic impact on both the highway traveler, and particularly the small aircraft pilot and passenger.

In short, there would be both positive and negative recreational impacts associated with the no action alternative at the Gakona site. Some small negative impacts associated with the construction effort would be expected, but larger impacts associated with access for recreational users and increased recreational aesthetics would also be realized.

Mitigation of the negative recreation impacts associated with the no action and associated reclamation effort would include encouraging the construction contractor to utilize local labor. This would prevent a major short-term taxing of local recreational resources.

4.12 AESTHETICS

The assessment of visual impacts is based on a determination of where changes to existing landscape features would occur as a result of construction or operation of the HAARP facility and an evaluation of the significance of these changes. For the Gakona site, the visual impacts of the proposed facility are based on the USAF's 1989 EIAP discussions of visual impacts that could have been caused by the OTH-B radar facility, previously proposed for the same site. For the Clear site, the visual impacts of the proposed facility are based on a site visit and photographs. The photographs included recent ground-based and aerial (oblique and stereoscopic) photographs. The method used for conducting the assessments is part of the standardized Visual Resource Management (VRM) system developed by the BLM, and is referred to as a Contrast Rating System. This system is described in BLM Manual 8431-1 (BLM, 1986).

4.12.1 Gakona Site

Impacts on Visual Resources. Visual impacts which would result from site development include clearing of vegetation, construction of gravel roads and transmitter shelters, and installation of antenna element piles, power cables, elevated groundscreen and a restriction fence. However, the HAARP facility would not be visible from the Glenn Highway or Richardson Highway because of intervening dense tree cover surrounding the sites. A brief view of the access road and staging area would be possible at the intersection with Highway 1 (Glenn Highway); however, visual contrasts from this vantage point would be weak and would not result in significant impacts. The visual contrasts of the IRI design (70-foot above ground) antennae would be less than the projected contrasts that would have been caused by the tallest portions of the formerly proposed OTH-B facility antenna backscreen (135 feet) and sounder antenna (150-feet) (USAF, 1989a). The visual contrasts of the IRI diagnostic facilities, including the VIS consisting of one 98-foot high and four 49-foot high towers, would also be less than the projected contrasts that would have been caused by the tallest portions of the formerly proposed OTH-B facility. Since only the tops of the 135-foot and 150-foot tall OTH-B antenna backscreen and sounder antenna, respectively, would have been visible, it can be concluded that

the 70 foot high IRI masts would not be visible from the highway. From the air the IRI and diagnostics would be highly visible at lower altitudes although to a lesser extent than the OTH-B facility would have been. It was concluded that the OTH-B would not detract from the highly scenic landscape features, such as the Wrangle Mountains, in the background setting, despite the fact that the OTH-B would have contrasted with the surrounding natural landscape elements in color, texture and line and that these visual contrasts would have attracted attention and begin to dominate the landscape scene (USAF, 1989a). It can therefore be also concluded that the smaller IRI would also not significantly detract from the visual setting. Visual contrasts for the preferred IRI site would be within VRM objectives for the Class III landscape. Visual impacts would not be significant.

All of the HAARP borrow area alternatives, previously discussed for the construction of an OTH-B radar facility (M&E/H&N 1989a; USAF 1989a), would involve clearing of vegetation and excavation, resulting in the modification of the existing landscape's color, texture and form. The conclusions of the USAF (1989a) for the OTH-B may be applied to the HAARP project. These conclusions were:

- Visual impacts to a private residence located at milepost 14.3 along the Tok Cut-Off and to adjacent ponds used for fishing would result from use of source P-1.

- Visual impacts to a 0.25 mile segment of the Tok Cut-Off while traveling northeast from Gakona would result from use of sources A-1 or A-5.

Visual contrasts range from moderate to strong and would result in short-term (less than 5 years) impacts to landscape character, until revegetation occurs. Neither short nor long term impacts associated with borrow mining would be significant.

Mitigation. The following mitigation measures would reduce or eliminate significant visual contrasts:

- Retain a 50- to 100-foot buffer of mature trees between public viewing points wherever possible.

- Selectively clear trees and brush only where necessary for safety and visibility along roads or for operational requirements such as security.

- Construct the diagnostic gravel service road to minimize the amount of land that would have to be cleared.

- Use access road right-of-way for utility lines to facilities.

4.12.2 Clear Site

Below is a discussion of the consequences of selecting the Clear site, and possible mitigation efforts that could be implemented. A discussion of the required near-term reclamation of the Gakona site, its consequences, and proposed mitigation as it relates to recreation is included under section 4.12.3 No Action Alternative.

Impacts on Visual Resources. Because the Clear site would include two separate locations that are somewhat different in aesthetic regards, it is necessary to assess and discuss these locations separately.

Visual contrasts resulting from site development at Clear AFS property, clearing of vegetation, construction of gravel roads and transmitter shelters, and installation of antenna element piles, power cables, elevated groundscreen and the exclusion fence, would not be visible from the Parks Highway because of intervening dense tree cover surrounding the sites. A brief view of the access road to the IRI site and the LIDAR site would be possible from the Clear/Anderson

spur road; however, visual contrasts from this vantage point would be weak and would not result in significant impacts. Visual impacts resulting from the optics and magnetometer site would be limited to viewing the gravel access road departing from the Parks Highway. Similar restrictive viewing conditions and viewer sensitivity would be encountered from the train tracks. The HAARP facilities at Clear AFS property would not be visible from the Nenana River.

Views of the IRI, LIDAR, and Optics and Magnetometer sites would be possible from a small aircraft at low altitude. However, considering the amount of buildings, roads, airfields, railroad trackage, and other man-made disturbances at the site, the construction of the IRI and the diagnostics would have a limited visual impact on the already disturbed Clear AFS property.

Obtaining small quantities of gravel from the existing borrow areas would not be significant from an aesthetic or visual perspective. In fact, filling in some of the many previously used old borrow locations with vegetation and loess material stripped from the construction sites could have a net positive aesthetic effect.

Visual contrasts for the proposed HAARP facility at the Clear AFS property would be within the BLM's Visual Resource Management (VRM) objectives for a Class IV site, which calls for minimal retainment of the existing character of the landscape. Thus, overall visual impacts of the HAARP facility at the Clear AFS property would not be significant.

Although the overall level of construction activity at the Bear Creek location is less than at Clear AFS, the visual impacts of the ISR and the VIS would be of much greater concern. As explained in the previous sections, the ISR consists of a large 115 foot diameter parabolic antenna which would be mounted on a pedestal and would swing an arc from aiming completely vertical (toward the zenith) to 30° from the vertical. It would be situated behind an earthen mound 110 feet tall. The 100-foot high guyed VIS would also be situated at the Bear Creek location. There are three main surface transportation corridors in the Nenana River Valley, including the Parks Highway, the Nenana River, and the Alaska Railroad. Each of these

transportation routes carries, to varying degrees, both resident and tourist observers. Other considerations are views of the site from homes and dwellings in the area.

Visual contact with the Bear Creek location equipment from the Nenana River would be very limited due to the dense conifer and deciduous tree cover along the banks and generally around the site, and the fact that the river level is approximately 30 feet below the surface elevation at the site, and almost half a mile away. In addition, this section of the river is floated rather infrequently as was reported in section 3.12, which further limits the visual impacts and viewer sensitivity.

The train tracks are located across the river from the ISR site and are roughly between 0.50 and 0.75 miles from the closest point of the ISR site. The train tracks are at a higher elevation than the river, but are also slightly further away. However, passenger trains run frequently in the summer, allowing passengers to view the area. The view of the ISR site from the tracks would not be imposing due to the distance it is away from the site, and the relatively short period of time that the ISR unit would be in view. Although there would be some visual detraction when viewed from the railroad tracks, it would be minimal due to the low viewer sensitivity.

The Parks Highway runs by the Bear Creek location at an elevation that is roughly 100 feet higher than the ground surface at the site. This provides a superior vantage point for viewing the valley, and thus, the impacts of the Bear Creek development from the highway would be significant. The 110 foot high earthen mound and the large parabolic dish antenna would be easily visible from highway for much of an approximately 2 mile stretch of highway northbound, and to a lesser extent for southbound traffic. The deciduous trees and the short conifers would afford little visual screening for this site.

There is currently one house in the Bear Creek area, located approximately 1 mile from the ISR and VIS location. Preliminary site investigation information suggest that there may not be direct visual contact between the dwelling and the ISR location (M&E/H&N, 1992a). In addition, the orientation of the site with the house provides a situation where the ISR and VIS units would be

partially obscured from view, even if all the vegetation were removed. Visual and aesthetic impacts insofar as the existing dwelling is concerned would be minimal. The impact on additional homes that could be constructed in the area cannot be projected, but could be substantial.

Views of the ISR site and the VIS equipment would be possible from small aircraft. Although there is a fair amount of man-made objects within the area by Alaskan standards, the ISR site would probably demand at least as much attention as the Parks Highway, the railroad tracks, and the over-head power lines. Although the construction at the Bear Creek location would have an impact on the visual resources from the air, the impact would be short in duration and not significant.

Visual contrasts for the proposed HAARP facility at the Bear Creek location would be within the BLM's Visual Resource Management (VRM) objectives for a Class II/III site, which calls for partial to substantial retainment of the existing character of the landscape. Whether the partial or substantial retainment would be necessary requires that the viewer sensitivity be either being medium or high. Viewer sensitivity is dependent on type of users, amount of use, public interest, and adjacent land uses.

Depending on whether the Bear Creek location is considered Class II or III for scenic quality rating, the proposed action may be within VRM objectives. The overall aesthetic impact of this site on the surrounding landscape would be low to moderate.

Mitigation. To reduce the effects of the visual impacts at the Clear Site, the following actions would be conducted:

- Retain a 50- to 100-foot buffer of mature trees between public viewing points wherever possible.

- Construction of the protective berm in front of the ISR should be done in a manner that suggests natural deposition of the material. This could be accomplished by making the mound asymmetric and irregular in plan and profile, as well as introducing native vegetation to the side-slopes.

- Access roads to HAARP equipment should be curved to prevent direct viewing of the site from major thoroughfares. The curved nature of the roads will also present a more natural and visually appealing site. At the Bear Creek location the access road should be configured to follow the existing grades.

- Access road clearings will be used to carry both overhead and subsurface power lines and communications cables. If overhead lines are used, timber poles as compared with open lattice steel frames could reduce the visual contrast.

- Buildings could be constructed of treated or self-weathering wood to blend with the natural rustic setting.

- Building and structure colors could be earth-tones, such as soft greens, blues, tans, and browns. Low reflectivity paint could also be used (flat and semi-gloss).

4.12.3 No Action Alternative

There would be no project impacts on aesthetics at the Clear site associated with the no action alternative. The no action alternative would result in both short- and long-term impacts at the Gakona site due to required near-term reclamation of the site. Short-term negative impacts on aesthetics would result from the increased level of construction at the site. However, these short-term negative impacts would be insignificant. The long-term positive aesthetic would result from the removal of the powerplant building and the return of the site to a near natural condition.

With the removal of the large powerplant building and the scarifying of the access roadway, it is possible that the highway traveler would not notice the access roadway. From the air, the site would appear disturbed for many years, but the with the powerplant building removed and vegetation starting to reestablish itself on the gravel surfaces, the visual impact will be greatly diminished.

Mitigation for this site could include using downed trees and other natural objects to clog the cut-line where the road intersects the Tok Cut-Off Highway. This simple action would provide a relatively natural looking visual barrier that would not call the motorist's attention to this clearing. In the long-term, natural succession of the area would ultimately reforest the disturbed area.

4.13 BIOEFFECTS OF RFR

RFR would be produced by the operation of the HAARP facility. RFR has quantum energies much lower than that associated with ionizing radiation, and is therefore classified as nonionizing radiation. Nonionizing radiation, such as RFR, adds heat energy to the body. Numerous studies indicate that biological effects occur when exposure levels are of sufficient intensity and duration. An exclusion fence will be built to prevent entry into areas where energies may be above exposure standards. Therefore, there would be no effects to humans and other animals remaining outside the exclusion fence. The placement of the exclusion fence is based upon calculations conducted by NRL (1992b). The upward directed IRI and ISR beams would pose no hazard to humans in aircraft passing through, because the aircraft would not remain in the main beam for any significant period of time. The power of the VIS is too low to be of concern. One of the design features discussed at the end of this section would be used to further minimize exposure to people in this case. Birds that roost on top of, or fly over, the antenna array would not be affected (AUSA, 1992b).

The placement of the exclusion fence and the conclusions that the IRI will not harm humans or animals beyond the fence were based upon:

- calculations of expected IRI operational near-ground level electric and magnetic fields (Table 4.13-1) (NRL, 1992b).

- calculations of expected variations in the electric and magnetic fields with altitude above the IRI during its operation (Table 4.13-2) (NRL,1993).

- maximum permissible RFR exposure limits for the general public established by the IEEE C95.1 - 1991 standard (Figure 4.13-1).

TABLE 4.13-1. CALCULATED ELECTRIC (E) AND MAGNETIC (H) FIELDS WITH DISTANCE FROM THE EDGE OF IRI

3 MHz TRANSMISSION ELECTRIC (E) AND MAGNETIC (H) FIELDS						
Distances From Edge of IRI (feet)	33	68	99	132	>132	IEEE C95.1 - 1991 Exposure Limits To The General Public[1]
E (Volts/meter)	330	174	111	78	<78	275 (Volts/meter)
H (Amps/meter)	0.7	.4	.3	0.2	<0.2	5.4 (Amps/meter)

10 MHz TRANSMISSION ELECTRIC (E) AND MAGNETIC (H) FIELDS						
Distances From Edge of IRI (feet)	33	68	99	132	>132	IEEE C95.1 - 1991 Exposure Limits To The General Public[1]
E (Volts/meter)	370	93	69	57	<57	82 (Volts/meter)
H (Amps/meter)	0.86	0.34	0.24	0.20	<0.2	1.6 (Amps/meter)

Source: NRL, 1992b.

TABLE 4.13-2. MAXIMUM ELECTRIC (E) AND MAGNETIC (H) FIELDS ABOVE THE IRI.

FREQUENCIES (Megahertz)	E FIELD (Volts/meter)	IEEE C95.1 - 1991 E FIELD (Volts/meter) EXPOSURE LIMITS[1]	H FIELD (Amps/meter)	IEEE C95.1 - 1991 H FIELD (Amps/meter) EXPOSURE LIMITS[1]	Altitudes of Maximum Field Strengths (Feet above ground)
2.8	191	294	.5	5.8	1,148
8.0	193	103	.5	2.0	3,198
10.0	193	82	.5	1.6	4,067

Source: NRL, 1993.

[1] 1991 guidelines for maximum exposure limits to the general public issued by the Institute of Electrical and Electronics Engineers C95.1 - 1991 standard. These limits are based on average durations of exposure of any 6 minute interval for magnetic field exposures and any 30 minute interval for electric field exposures.

- the *Analysis of the Potential For Radio Frequency Radiation Bioeffects To Result From Operation Of The Proposed ONR And Air Force High-Frequency Active Auroral Research Program Ionospheric Research Instrument (HAARP IRI): General Analysis (Not System Specific)* (AUSA, 1992a)

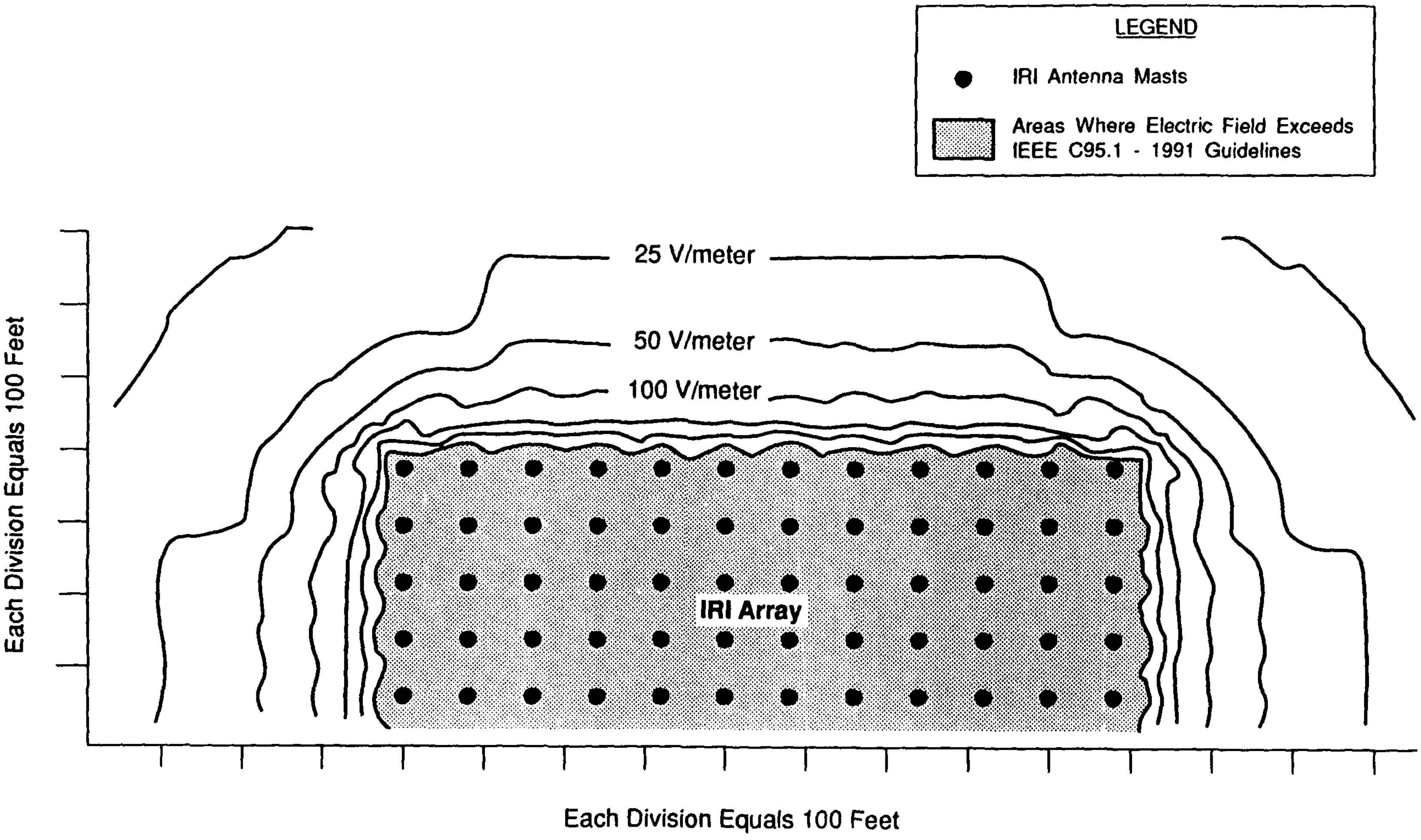
- the analysis of the vast amount of literature regarding the bioeffects of RFR exposure to humans as it relates specifically to the HAARP IRI (AUSA, 1992b).

The following environmental analysis applies to both the Gakona and Clear sites since the effect of HAARP generated non-ionizing RFR on biological organisms would be similar at both sites. Effects are evaluated for both humans and other biological organisms that could be affected by the operation of the IRI. The no action alternative would have no potential effects, since no RFR would be produced.

4.13.1 Near Ground Field Strengths

Calculations were made of the expected near ground level electric (E) and magnetic (H) fields based on the computer modeling of the stacked IRI design configuration, including the ground screen (NRL, 1992b). The geometric and spatial parameters of the antenna elements, including the ground screen, were modeled and various frequencies and combinations of elements were evaluated. Electric and magnetic field strengths were found for various distances out from the modeled elements and plotted (Figure 4.13-1). The field strengths were calculated at the edge of the proposed ground screen (33 feet away from the perimeter of the array) and other variable distances from it (Table 4.13-1).

Figure 4.13-1 conceptually illustrates the distribution of the electric field strength around the IRI array at a 2 meter height. Only one end of the 12 X 15 array is shown since the fields would be symmetrical around the array. In this figure the array is operating at a frequency of 3 MHz and at maximum power level.



PLAN VIEW

NOTES: Contours at 6 Ft. Above Ground Level. IRI Operating at 3 MHz Frequency.
Contours Symmetric for Other End of IRI.
Field Decays More Rapidly at Higher Frequencies.

FIGURE 4.13-1. ELECTRIC FIELD CONTOURS AROUND THE IRI ANTENNA ARRAY

None of the NRL (1992b) calculated H field strengths exceeded the IEEE C95.1 - 1991 guidelines for allowable exposure to the general public (Table 4.13-1). The E field strength generated by 3 MHz transmissions fell below the IEEE C95.1 - 1991 exposure limits approximately 50 feet away from the edge of the IRI, 17 feet outside the edge of the ground screen (Table 4.13-1). The E field strength generated by the 10 MHz transmissions fell below the IEEE C95.1 - 1991 exposure limits approximately 83 feet away from the perimeter of the IRI, 50 feet outside the edge of the ground screen.

The ISR operates at less power than the IRI and the VIS operates at much less power than both the ISR and the IRI. The ground level field strengths adjacent to these diagnostics instruments are all within the allowable exposure limits to the general public at both the Gakona and Clear sites (MITRE, 1993a). No exclusion fence in necessary for either the ISR or VIS.

The field strength outside the IRI exclusion fence is within safety exposure limits. The field strengths at the ISR and VIS are within safety exposure limits (no fence required). Since the field strength of each emitter decreases rapidly with distance, safety exposure concerns become less significant with distance. Because of the rapid loss of field strength with respect to distance, the highest value of the combined field strengths would be found at the edge of the emitting antennas. At no point, outside the exclusion fence of the IRI, is the safety threshold exceeded for the combined field strengths of all the emitters at both the Gakona and Clear sites (MITRE, 1993a). Additionally, the simultaneously operation of BEMWS at the Clear site does not change this conclusion (MITRE, 1993b).

4.13.2 Above Ground Field Strengths

The altitudes of the maximum E and H fields above the proposed IRI were calculated (NRL, 1993) as a function of 3 expected operational frequencies: 2.8 MHz (lowest operational frequency), 8.0 MHz, and 10.0 MHz (highest operational frequency). The maximum fields were calculated to assess the potential consequences to occupants of aircraft flying over or birds that may roost on or fly over the array (Table 4.13-2). The IEEE C95.1 - 1991 exposure limits

for the general public ("uncontrolled environment," Table 3.13-1) allows E field exposures to be averaged over any 30 - minute period for the frequency band 3 MHz to 10 MHz.

Exposure to Humans. The IEEE C95.1 - 1991 exposure limits for the general public would not be exceeded for either electric or magnetic fields at any altitude when the IRI is operated at 2.8 MHz. However, at higher frequencies such as 8.0 and 10.0 MHz the E field strengths could exceed the IEEE C95.1 - 1991 E field exposure limits for 30 minute exposures within different altitude ranges, indicating that the IRI could potentially pose a hazard to occupants of aircraft flying nearby and over the IRI in the unlikely event they remain in the main beam for an extended period of time. Because aircraft would be in the beam for only a very short period, the permitted E field exposures may be increased in inverse proportion to the time in the beam. The IEEE C95.1 - 1991 exposure limits for the general public would not be exceeded from the operation of the VIS. The exposure standards could be exceeded above the ISR during its operation (MITRE, 1993a). The location where the exposure standard would be exceeded above the ISR resembles an acute angle inverted cone with the apex at the ISR. The cone extends upward and outward to 30,000 feet above the ground where it has a diameter of 36,000 feet. The cone is formed by rotating the narrow ISR beam through its possible research angle (about 30°) from the zenith. It would be unlikely that a person would occur in the cone. In the unlikely event someone where to occur in the cone, the probability that they would encounter the narrow beam would be less than 1 percent. Even in the extremely unlikely event someone would encounter the beam, they would have to remain in the beam long enough to exceed exposure limits (MITRE, 1993a). Based upon this necessary sequency of improbable events, it is, therefore, concluded that potential health hazards from the emitters would be negligible.

Simultaneous operation of the IRI, ISR, and VIS at either site does not change this conclusion. The safety exposure limit would be exceeded from the individual IRI and ISR emissions, rather than the combined operation of all the emitters (MITRE, 1993a). Similarly, the simultaneous operation of the BMEWS radar (at Clear AFS), IRI, ISR, and VIS does not change this conclusion (MITRE, 1993b).

To prevent aircraft occupants from being exposed to levels of RFR higher than the IEEE C95.1 - 1991 exposure standard, the IRI is being designed with an aircraft detection system and all appropriate emitters will be shut off automatically if any aircraft approaches. On this basis, the IEEE C95.1 - 1991 maximum permissible exposures would not be exceeded by aircraft occupants passing over the antenna.

Exposure to Birds. The 0.4 watt per kilogram RFR exposure basis for the IEEE C95.1 - 1991 exposure limits for humans was used to calculate the specific absorption rate (SAR) for birds (AUSA, 1992b). According to the calculations, a bird up to the size of about 3 pounds in weight and 16 inches in body length would not exceed the SAR of 0.4 watts per kilogram at E field strengths less than 1228 volts per meter at 10 MHz. Hence there is no significant risk to birds flying over or roosting on the IRI because (AUSA, 1992a,b,c):

- at 10 MHz the maximum E field strength above the IRI was calculated to be 193 volts per meter (Table 4.13-2), well below the 1228 volts per meter exposure threshold for birds.

- the calculated maximum E field strengths at operational frequencies less than 10 MHz will all be almost an order of magnitude lower than the exposure limits.

Mitigation. An exclusion fence would be built around the IRI to prevent the general public and mammals from being exposed to any near ground RFR that exceeds the IEEE C95.1 - 1991 maximum exposure limits. The fence would be built at least 50 feet away from the edge of the ground screen, 83 feet or more from the edge of the IRI array, where the expected RFR exposure would drop below permissible levels. Since the design specification for the construction of the IRI already includes an aircraft detection system to turn off the appropriate emitters when an aircraft approaches, there is no need to suggest a mitigating measure for the potential impacts to aircraft occupants. Furthermore it is doubtful that aircraft would remain in a beam for a length of time that would be sufficient to exceed the time averaged exposure limits.

4.13.3 No Action Alternative

Selection of the no action alternative would result in no RFR being generated. Thus, there would be no adverse impacts to humans and animals from RFR at either of the sites.

4.14 ELECTROMAGNETIC AND RADIO FREQUENCY INTERFERENCE

Transmissions from the HAARP transmitters, IRI, ISR, and VIS, would change portions of the electromagnetic environment in the vicinity of the HAARP facility and, to a lesser extent, at locations distant from HAARP (MITRE, 1992b,c,d,e). The changed portions of the electromagnetic environment would consist of the operational frequency ranges of the IRI, ISR, and VIS and associated secondary frequency ranges (harmonic and spurious emissions). HF communications, FM radio, mobile VHF and UHF radios, wildlife trackers, citizen band radios, and VHF and UHF radio telephone systems, cellular telephone and Trans-Alaska Oil Pipeline maintenance communications could be impacted by HAARP transmissions. However, real world conditions such as variable topography, vegetation, structures, condition and age of the receiving system technology, and atmospheric conditions on sky wave propagation make it very difficult to reliably predict specific interference effects to receiver systems. One of the world's most powerful IRI's is currently operating in Tromso, Norway. It is roughly one-quarter as powerful as the proposed HAARP IRI. However, it is nonetheless encouraging to note that broadcast radio, television, and telecommunications successfully operate within close proximity to the facility (MITRE, 1992c). Furthermore, satellite television signals are successfully received, without interference, from a satellite dish mounted on the roof of a building within 300 feet of the facility. In addition, during more than a decade of development, testing, and operation of large, powerful high-frequency over-the-horizon backscatter radars, in a mode similar to that proposed for the HAARP IRI, there has been but one confirmed report of interference and none within the International Broadcast Bands.

The effect of the HAARP project on surrounding receivers was studied and modeled in separate technical reports (MITRE, 1992b,c,d,e). These reports are summarized in the remainder of Section 4.14.

4.14.1 HAARP Transmitters

Operation of the three primary HAARP emitters (IRI, ISR and VIS) would change the electromagnetic environment over the frequency bands of their operation (and their harmonic frequencies and spurious emissions) within the physical space reached by their energy.

Civilian use of the radio spectrum is under control of the Federal Communications Commission (FCC) while government use is under the control of the National Telecommunications and Information Administration (NTIA). Because HAARP is a Department of Defense research and development program, an application for experimental spectrum support has been submitted by the Air Force to the Interdepartmental Radio Advisory Committee (IRAC) of the NTIA, which will consider and authorize, as appropriate, the operation of the HAARP emitters.

The HAARP IRI would transmit in the HF portion of the electromagnetic spectrum, from 2.78 to 10.0 megahertz (MHz). An important characteristic of radio signals within this frequency band is that they can be refracted by layers of naturally occurring ionization at heights above approximately 31 miles. The refraction results in these radio signals returning to earth over a broad area. This is referred to as sky-wave propagation. Lesser amounts of the radio signal are transmitted by direct line-of-sight wave propagation and ground wave propagation. The ground wave signal is attenuated relatively rapidly as it propagates away from the emitter sources. The HF band at the IRI frequencies is shared with radars (operational and experimental), radio systems for air-to-ground and ship-to-shore communications, systems for standard time and frequency broadcasts, the Amateur Radio Service, Citizens Band radio and others.

The IRI would have the capability to illuminate the ionosphere within a maximum cone angle of 60 degrees, centered on the zenith. The IRI may or may not change frequency each time it switches its beam to illuminate a different portion of the ionosphere within the 60 degree cone angle. Ionospheric conditions, which change with solar activity, time-of-day, and season of the

year dictate the particular range of frequencies that would be used to investigate ionospheric processes and their interaction with radio wave energy.

The HAARP VIS would transmit in the 1.0 to 15.0 MHz portion of the high frequency band. The VIS operates at much lower power than the IRI and is used to aid in selecting frequencies for operating the IRI and as a diagnostic instrument to assess the background ionosphere and changes induced by the IRI. A VIS is a common instrument used to monitor the ionosphere at many world locations.

The HAARP ISR would transmit in the 440 to 450 MHz portion of the ultra high frequency (UHF) band. This band is shared with radars such as the BMEWS. The ISR is a diagnostic instrument used primarily for detailed assessments of the background ionosphere and the changes induced by the IRI. The majority of the radio frequency energy from the ISR travels through the ionosphere and escapes into space.

Not all of the radio frequency energy transmitted by the HAARP emitters is concentrated in the main beams. The peak power in the side-lobes is approximately 1/20th of the peak power in the main beams. Much smaller concentrations of power appear in the sidelobes of the emitter antennas.

The HAARP emitters would produce signals on frequencies other than the intended ones, but at much lower power levels. This is a characteristic of all radio frequency emitters. Some of the emitted frequencies are integer multiples of the intended, or fundamental, frequency and are termed harmonics. Others are less clearly related to the fundamental frequency, and are called spurious emissions. Care would be taken in the HAARP system designs to minimize such signals because they both are a waste of transmitter power and a potential source of interference to other user systems.

When a radio wave transmitter emits a modulated signal in its desired frequency band, it also emits some energy in the directly adjacent portions of the spectrum, which propagates along

with the desired signal and creates the possibility of adjacent-channel interference. The possibility of adjacent channel interference is why television channels, such as 9 and 10, are not used in the same community. The modulation of the HAARP emitters will be designed to minimize the out-of-band radio frequency energy; the transmitted signals will have good spectral purity.

In addition to the three primary aforementioned HAARP emitters, HAARP would employ several auxiliary transmitting systems. These systems include:

a. VHF or UHF land mobile radio systems to support intra-site maintenance and security activities. These would be standard, commercially available transceivers such as those used by police, fire departments, and the Forest Service. These vehicle-mounted or hand-carried systems would operate on frequencies assigned by the National Telecommunications and Information Administration (NTIA) through the Interdepartmental Radio Advisory Committee so as to avoid interference to other users of the land mobile frequency bands. Emissions from these HAARP auxiliary emitters will not be discussed further as they are commonly used, of low power, and would operate on frequency bands assigned for this purpose.

b. Data links for the operation and control of off-site diagnostic instrumentation and for transmission of diagnostic data to the main HAARP site where it would be collated, analyzed, and displayed for use by all experimenters. Commercial telephone lines and/or a microwave radio system would be employed as data links. These commercial systems are used throughout Alaska and are licensed and administered by Federal and State agencies.

4.14.2 Effects of the HAARP Emitters on User Systems

The addition of the three primary HAARP emitters to the electromagnetic environment of the HAARP study areas could affect systems that use the same environment as well as systems that

are not intended to receive electromagnetic energy. Other users of the electromagnetic spectrum include for example: HF communications, radio, television and radionavigation systems (aircraft avionics, e.g., LORAN). Systems or processes not intended to receive electromagnetic energy that could be affected include cardiac pacemakers, electroexplosive devices (EEDs) and fuel handling.

The objective of this section is to identify user systems that potentially could be impacted by the HAARP emitters. Reliable predictions of HAARP emitter impacts on user systems in real-world, specific environments is difficult. Rather the reader is encouraged to evaluate the approach being employed and to look at the assessments made as an indicator of potential interference scenarios. The details of actual interference occurrences would depend on many factors not considered in this assessment. These factors include topography, vegetation, structures, condition and age (technology employed) of the receiving systems, and atmospheric conditions.

In general, the potential impacts (interference) to users and potential users of the electromagnetic spectrum would increase with closer proximity to the site. Of the two primary types of waves associated with the HAARP emitters, sky waves and ground waves, the sky waves would cause the greatest potential impact to global and HAARP vicinity receivers because of the refractive and reflective long distance propagation effect of the ionosphere and the earth's surface. The basis for these conclusions are presented in MITRE (1992c) and are summarized below.

HAARP IRI Signals Propagated by Sky Wave. The HAARP IRI would transmit a significant fraction of its radio frequency energy skyward into a beam that varies between a six and twenty degree cone angle. The IRI, from 2.8 to 8.0 MHz, would be able to steer this relatively narrow beam within a 60 degree cone angle centered on the zenith. Above 8.0 MHz, the beam steering capability would decrease from a 60 degree cone angle to a 20 degree cone angle at 10.0 MHz.

Experience with similar facilities (e.g., Arecibo and Tromso) suggest that 80-90% of the experiments would employ the IRI in modes that refract fundamental radio frequency energy

earthward from the ionosphere. This refracted radio frequency energy illuminates a broad area on the ground and in turn is reflected and scattered skyward. The process repeats until the radio wave escapes into space or is attenuated below background noise levels. In daytime or beneath an active morning sector (approximately midnight to 6:00 AM local time) aurora, the ionosphere is absorptive and the radial distance to which the sky wave can illuminate the earth is reduced.

In addition to the fundamental and adjacent frequencies, it is possible for some of the lowest harmonics and spurious signals also to propagate by sky wave and be reflected back to earth, depending on the ionospheric conditions. However, only those frequencies below approximately 40 MHz would ever propagate by sky wave, and in general they propagate with a "skip zone" that precludes the energy being returned to earth within a circular area, with a radius of 100s of miles about the IRI site. Signals above approximately 40 MHz are lost to space and would not propagate to distant regions.

The specific portions of the HF band within which the HAARP IRI would transmit are those bands also employed by transmitters of the Fixed Service and the Broadcast Service. The users of the Fixed Service operate fixed (i.e., not mobile), point-to-point links for the transmission of data or information from one part of the globe to another. Before the advent of communication satellites, the U.S. Armed Forces were major users of the Fixed Service bands, operating large transmitting and receiving systems in Hawaii, California, and other locations worldwide. The Broadcast Service transmitters are also located throughout the world, broadcasting news, music, religious and other programs. The Broadcast Services use the HF bands because the sky wave allows them to propagate their programming to areas at great distances from the transmitter, reaching audiences they could not otherwise reach. Among these transmitters are Radio Moscow, the Voice of America, and the British Broadcasting Corporation. The listeners to the Broadcast Services are located throughout the world.

HAARP IRI Signals Propagated by Ground Wave. Some of the radio frequency energy radiated by the IRI antenna system is expected to remain near the earth's surface where it propagates by ground wave, becoming attenuated as a function of distance from the IRI more

rapidly than the sky wave or line-of-sight wave. Several first-order factors govern the efficiency of ground wave propagation. The IRI antenna is designed to suppress the launching of groundwaves. Hilly and mountainous terrain as well as ground conductivity attenuate ground waves. In addition, frozen soil or permafrost are relatively poor conductors and therefore affect the efficiency of ground wave radiation.

The strength of the ground wave is of most interest close to the site. However, as discussed in MITRE's report (1992c), the strength of the line-of-sight signal is greater than the ground wave at distances beyond approximately 1000 feet. Research objectives may dictate the choice of operating frequencies such that sky waves could potentially affect systems in areas adjacent to the HAARP site and extend radially hundreds of miles. Reception of the IRI ground wave signal beyond distances of approximately 31 - 62 miles is of reduced interest because the sky wave received signal tends to dominate. Areas shadowed from line-of-sight IRI signals, and within approximately 31 miles radial distance, may experience ground wave signals of greater strength than the sky wave.

Available Frequencies. The NTIA is expected to authorize the HAARP IRI to operate on a "clear channel, noninterference basis" within specific bands of the high frequency (HF) portion of the radio spectrum. The expected specific bands are those shared with users of the Fixed and Broadcast Services. As stated earlier, the Fixed Service is intended for point-to-point transfer of information between two cooperating fixed (i.e., not mobile) stations. The Broadcast Service uses transmitters located throughout the world and is operated by private industry, governments, religious organizations and other groups.

All other portions of the HF band, including the bands occupied by the Aeronautical Mobile and Marine Mobile Services, Amateur Radio Service (i.e., the Hams) and the standard frequencies will be forbidden to the HAARP IRI. The first two services are used for communication between and among aircraft, ships and shore or ground stations. The Hams are hobbyists who communicate with other Hams throughout the world using the HF bands. The Standard Frequency bands support, for example, the transmission of precise time and frequency

information as well as propagation predictions, solar and geophysical data. The Standard Frequency stations are operated by national government agencies and include WWV in Colorado, CHU in Ontario, and JJY near Tokyo. Table 4.14-1 is a summary listing of the distress, calling and guarded frequencies that the IRI must not operate on.

Selection of the HAARP IRI Operating Frequency. From the list of frequency bands authorized for HAARP use on a clear channel, noninterference basis, a specific, narrow (up to 200 kHz) frequency band would be identified that would be compatible with observed ionospheric and auroral conditions, research objectives, would not be occupied by another radio spectrum user, and would not be one of the forbidden frequencies. Ionospheric conditions would be determined from the VIS which provides information on the electron density variation with altitude. Auroral conditions would be determined from a variety of instruments, including the optical and the infrared imagers, the magnetometer, the imaging riometer and from other space environmental diagnostics that may be available from, for example, the University of Alaska and/or the National Space Environmental Support Center cooperatively operated by the USAF and the National Oceanographic and Atmospheric Administration. A spectrum monitor would scan the frequency bands (outside the forbidden frequencies) that would meet the research objectives and would determine the noise floor level and the channel width. From the results of the spectrum monitor scan, the operator selects (or confirms an automated frequency selection) a frequency(ies) and begins/continues the IRI operation. The IRI would have the capability to operate simultaneously on any two distinct frequencies within its operating range.

Assessment of Potential Interference. The following information was used to access whether the proposed HAARP transmissions would impact an existing or proposed system:

- Existing or proposed location of the receiving system
- The intended frequencies of operation
- The nature of the receiving antennas
- The sensitivity of the receiving system

TABLE 4.14-1 DISTRESS, CALLING, AND GUARDED FREQUENCIES

FREQUENCY (MHz)	ALLOCATED SERVICES
2.706 $\pm$ 0.002	Emergency Net - Atlantic and Pacific
3.023 $\pm$ 0.002	Search and Rescue (SAR) Control -
4.050 $\pm$ 0.002	Emergency Net - Atlantic and Pacific
5.000 $\pm$ 0.005	Standard Frequency
5.320 $\pm$ 0.005	International Ice Patrol
5.680 $\pm$ 0.020	SAR Control - Atlantic and Pacific
5.6814 $\pm$ 0.020	SAR Control - Atlantic and Pacific
6.204 $\pm$ 0.020	SAR Control - Atlantic and Pacific
6.2054 $\pm$ 0.020	SAR Control - Atlantic and Pacific
6.273 $\pm$ 0.010	Aircraft Comm. to Maritime Mobile Stations
7.5084 $\pm$ 0.020	Hurricane Warning Net
7.530 $\pm$ 0.020	Emergency Net - Atlantic and Pacific
8.364 $\pm$ 0.020	SAR Control - Atlantic and Pacific
8.502 $\pm$ 0.005	International Ice Patrol
8.7564 $\pm$ 0.005	International Ice Patrol
10.000 $\pm$ 0.005	Standard Frequency

Note: Bandwidths are representative

Since the impacts to users of the electromagnetic environment would increase with closer proximity to the HAARP emitters a conservative approach was taken and theoretical upper bounds of the potential effects to the receiving systems closest to the IRI, under ideal transmitting and receiving conditions were examined (MITRE, 1992b,c,d,e). The results of the analysis are summarized below.

The characteristics (antenna, and receiver sensitivity) of the user receiving system population, even though from a single family (e.g., AM or VHF mobile radios) may differ markedly by manufacturer, age (technology employed) and condition of the system. However, an approach has been taken to model representative characteristics of user receiving system families. The model is described in MITRE (1992d) and the result of this model is the definition of a "receiving system sensitivity" (expressed in power per unit area i.e., watts per square meter) for each family of user systems. This receiving system sensitivity (for users of the electromagnetic spectrum) is the predicted incident, plane-wave power density equivalent to the noise level (referred to the input terminals of an equivalent lossless receiving antenna) that the receiving system would experience in the absence of the HAARP emitters. For systems that could be affected by the electromagnetic environment, such as EEDs or pacemakers, the receiving system sensitivity, is the threshold below which safe operation occurs. The HAARP emitters' addition to the electromagnetic environment has been estimated at the frequency and location of the user systems analyzed. The approach and techniques used to estimate the HAARP emitter power densities are described in MITRE (1992c).

For the user systems that operate above 10 MHz (the top frequency of the Ionospheric Research Instrument) and remote from the HAARP study areas, potential interference from the IRI could occur only through harmonic and spurious or by fundamental overload. It is quite likely that any IRI interference experienced by such users above 10 MHz would be via line-of-sight, propagation. Sky wave propagation, of IRI harmonic and spurious emissions, is less likely because the energy may be lost into space; may require lossy, "multi-hop" propagation between the ionosphere and the ground; and would originate from the IRI antenna that disperses the out-of-band radio frequency energy over the upper hemisphere, rather than into a focused beam.

A worst case estimate of whether a user system could be potentially affected was obtained using the results from MITRE (1992b,c) which estimated the impact on user systems through the ratio of the HAARP emitter estimated power densities to the receiving system sensitivities. The estimates were based largely on worst-case, line-of-sight propagation. Such propagation to ground-based users is limited in range by the Earth's curvature, and the strength of the received

signal is impacted by intervening topography, structures and vegetation. Tables 4.14-2 and 4.14-3, for the Gakona and the Clear regions respectively, summarize the receiving system sensitivities, HAARP emitter incident power densities, and the predicted level of impact for each family of systems that may be employed or inadvertently affected in the HAARP study areas.

In cases where the theoretical maximum interference indicates the potential for an impact the actual impact would depend upon site specific and physiographic conditions. To determine whether or not such an impact would really occur, a site specific interference monitoring program would be required. From Tables 4.14-2 and 4.14-3, it is concluded that the systems potentially affected by IRI interference could include HF Communications, mobile VHF radios, TV, wildlife trackers, hand held transceivers, citizen band radios, and cellular telephones. LORAN (100 kHZ) is another commonly used aircraft navigation system. The HAARP IRI, ISR, and VIS would not emit at any subharmonic frequency that would impact a LORAN aircraft navigation system.

The HAARP ISR would potentially affect the performance of UHF hand-held transceivers and UHF radio telephone systems. The HAARP VIS would potentially affect similar systems to those affected by the IRI, as both systems operate in the lower one half of the high frequency band. Mitigation of these potential affects are discussed later in the following section. The radiated power of the VIS is 60,000 times less than the IRI; the VIS high frequency antenna pattern has approximately 400 times less gain than the IRI antenna; the VIS antenna as an out-of-band emitter distributes the power over 10-15 elements into an inefficient spikey pattern; the VIS sweeps in frequency which means that if interference episodes do occur, they will be short-lived and when converted to audio frequencies there will be a short buzz or click. Such sounders are operated on a non-interference basis throughout the world and in general are compatible with the shared use of the radio frequency spectrum. These considerations suggest that the VIS will not be a significant source of interference.

TABLE 4.14-2. THEORETICAL MAXIMUM RADIO FREQUENCY INTERFERENCE TO RECEIVING SYSTEMS BY HAARP TRANSMISSIONS IN THE GAKONA AREA

RECEIVING SYSTEMS	FREQUENCY RANGE (MHz)	[1] THEORETICAL MAXIMUM INTERFERENCE		
		IRI	ISR	VIS
Cellular Telephone	870 - 890	impact	inconclusive	inconclusive
Satellite Television	5925 - 6875 12,500 - 12,750	no impact no impact	no impact no impact	no impact no impact
HF Communications	2.1 - 10 10 - 30	impact impact	no impact no impact	impact impact
Television Broadcast	60 - 88 88 - 200 200 - 216	inconclusive no impact inconclusive	no impact no impact no impact	impact impact impact
AM Radio Broadcast	0.535 - 1.7	no impact	no impact	impact
FM Radio Broadcast	92.9 - 106.7	no impact	no impact	no impact
[2]Avionics	GPS 1227, 1575 VHF Radio 118 - 137 UHF Radio 960 - 1125 VOR 115 - 116 ADF 0.25 - 0.40	95 feet 1.6 miles 6.1 miles 0.6 miles in main beam	500 feet in main beam 2.5 miles in main beam in main beam	< <3300 feet 32 miles 3.0 miles 20 miles in main beam
Mobile VHF Radio	38 - 88 88 - 161	impact inconclusive	no impact no impact	impact impact
Wildlife Trackers	30 - 88 88 - 200 200 - 222	impact inclusive impact	no impact no impact no impact	impact impact impact
Citizen Band Radio	26.9 - 27.4	impact	no impact	no impact
Hand Held Transceivers	VHF 118 - 174 UHF 403 - 470	inconclusive impact	no impact impact	impact impact
Radio Telephone	VHF 152-158 UHF 454-460	no impact no impact	no impact impact	impact no impact
Pipeline Systems	Control 157, 162 Maintenance VHF Communications 150-162 Maintenance UHF Communications 450-460	no impact no impact no impact	no impact no impact impact	impact impact impact
Microwave On Ground	5945-6094	no impact	no impact	no impact
Cardiac Pacemakers	Incident Pulsed Incident CW	no impact no impact	no impact no impact	no impact no impact
[3] EED's On Ground	Exposed In Metal Container	impact no impact	impact no impact	no impact no impact

continued.

TABLE 4.14-2 continued. THEORETICAL MAXIMUM RADIO FREQUENCY INTERFERENCE TO RECEIVING SYSTEMS BY HAARP TRANSMISSIONS IN THE GAKONA AREA

RECEIVING SYSTEMS	FREQUENCY RANGE (MHz)	[1] THEORETICAL MAXIMUM INTERFERENCE		
		IRI	ISR	VIS
[3] EED's In Aircraft	Exposed	impact	impact	no impact
[4] Aircraft Flight Control Systems	FAA Electric Field Standard	9,000 ft radial 16,000 ft altitude	2,500 ft radial 4,000 ft altitude	not required

Source: MITRE, 1992b; 1992d: 1992e; 1992f; 1993a; 1993c.

[1] Theoretical maximum interference based upon a ratio of HAARP signal power density to the receiving system's sensitivity where: "no impact" = ratio less than 1; "inconclusive" = ratio approximately equal to 1; "impact" = ratio greater than 1.

[2] Theoretical maximum interference for avionic systems is given as the radial distance from the respective transmitter at which the interference potential becomes minimal. At further radial distances no potential exists. At closer distances a potential for interference exists.

[3] Recommended EED safe separation distances and the corresponding power densities are given by formulas contained in Air Force Regulation 127-100.

[4] Based upon United States Certification Environment provided to aircraft manufacturers by the FAA.

Abbreviations Defined: HF = high frequency; FM = frequency modulation; ADF = automatic Direction Finder; AM = amplitude modulation; UHF = ultra high frequency; GPS = global positioning system; VHF = very high frequency; VOR = VHF omnidirectional range

Assumptions used in the estimation of theoretical maximum for interference:

MITRE, 1992b

a. IRI transmitter harmonics lie 80 dB below the carrier for frequencies below 45 MHz and lie 120 dB below the carrier for frequencies above 45 MHz.
b. ISR transmitter harmonics lie 80 dB below the carrier for frequencies below 1 GHz and lie 100 dB below the carrier for frequencies above 1 GHz.
c. IRI and ISR transmitter subharmonics are negligible.
d. Propagation loss is that of free space for line-of-sight paths.
e. A diffraction loss of 30 dB is applied to non-line-of-sight paths.
f. An absorption loss of 5 dB is applied to sky-wave (HF) paths.
g. The IRI waveform is CW.
h. The IRI waveform is pulsed, with a 0.5 MHz bandwidth.
i. The pattern of the IRI antenna well outside the HF band is random with no main beam or grating lobes, and the directivity is that of an isotropic radiator in the upper hemisphere (3 dB).
j. The ISR pattern is that of a parabolic dish of 1000 m^2 aperture, as specified by a semi-empirical model.
k. IRI antenna element efficiency above the HF band is - 10 dB.

MITRE, 1992d

a. Receiving system sensitivities are for the space wave only (line of sight wave plus the sky wave) and does not include the groundwave.
b. The HAARP emitters are in the far field of the receiving antennas. However, the receiving systems may be in the near field of the HAARP emitters.
c. The ambient temperatures of the receive antenna circuit, matching network, and transmission line are equal to the noise factor reference temperature at 288° K (59° F).
d. The signal/noise processing factors of the receiving systems are equal to unity.
e. The external system noise is equal to quiet-rural-noise.
f. The receive antenna directivities are equal to the peak directivities of the antennas for a worse case sensitivity to electromagnetic interference. MITRE (1992c) modifies these antenna directivities to account for the receive directivity in the direction of the HAARP emitters.

MITRE, 1992e

a. The closest ranges of the HAARP emitters to the user receiving systems are utilized to assess the worst cases of electromagnetic interference.

TABLE 4.14-3. THEORETICAL MAXIMUM RADIO FREQUENCY INTERFERENCE TO RECEIVING SYSTEMS BY HAARP TRANSMISSIONS IN THE CLEAR AFS PROPERTY AND BEAR CREEK LOCATION AREAS

RECEIVING SYSTEMS	FREQUENCY RANGE (MHz)	[1] THEORETICAL MAXIMUM INTERFERENCE		
		IRI	ISR	VIS
Cellular Telephone	870 - 890	impact	impact	impact
Satellite Television	5925 - 6875 12,500 - 12,750	no impact no impact	no impact no impact	no impact no impact
HF Communications	2.1 - 10 10 - 30	impact impact	no impact no impact	impact impact
Television Broadcast	60 - 88 88 - 200 200 - 216	inconclusive no impact inconclusive	no impact no impact no impact	impact impact impact
AM Radio Broadcast	0.535 - 1.7	no impact	no impact	impact
FM Radio Broadcast	92.9 - 106.7	no impact	no impact	impact
[2]Avionics	GPS 1227, 1575 VHF Radio 118 - 137 UHF Radio 960 - 1125 VOR 115 - 116 ADF 0.25 - 0.40	95 feet 1.6 miles 6.1 miles 0.6 miles in main beam	500 feet in main beam 2.5 miles in main beam in main beam	< <3300 feet 32 miles 3 miles 20 miles in main beam
Mobile VHF Radio	38 - 88 88 - 161	impact inconclusive	no impact no impact	impact impact
Wildlife Trackers	30 - 88 88 - 200 200 - 222	impact inconclusive impact	no impact no impact no impact	impact impact impact
Citizen Band Radio	26.9 - 27.4	impact	no impact	impact
Hand Held Transceivers	VHF 118 - 174 UHF 403 - 470	inconclusive impact	no impact impact	impact impact
[3] Radio Telephone	VHF 152-158 UHF 454-460	- -	- -	- -
Pipeline Systems	Control 157, 162 Maintenance VHF Communications 150-162 Maintenance UHF Communications 450-460	no impact no impact no impact	no impact no impact impact	no impact no impact no impact
Microwave on Ground	2127-2177	no impact	no impact	no impact
Cardiac Pacemakers	Incident Pulsed Incident CW	no impact no impact	no impact no impact	no impact no impact
[4] EED's On Ground	Exposed In Metal Container	impact no impact	impact no impact	no impact no impact

continued.

TABLE 4.14-3 continued. THEORETICAL MAXIMUM RADIO FREQUENCY INTERFERENCE TO RECEIVING SYSTEMS BY HAARP TRANSMISSIONS IN THE CLEAR AFS PROPERTY AND BEAR CREEK LOCATION AREAS

RECEIVING SYSTEMS	FREQUENCY RANGE (MHz)	[1] THEORETICAL MAXIMUM INTERFERENCE		
		IRI	ISR	VIS
[4] EED's In Aircraft	Exposed	impact	impact	no impact
[5] Aircraft Flight Control Systems	FAA Electric Field Standard	9,000 ft radial 16,000 ft altitude	2,500 ft radial 4,000 ft altitude	not required

Source: MITRE, 1992b; 1992d: 1992e; 1992f; 1993a; 1993b; and 1993c.

[1] Theoretical maximum for interference based upon a ratio of HAARP signal power density to the receiving system's sensitivity, where: "no impact" = ratio less than 1; "inconclusive" = ratio approximately equal to 1; "impact" = ratio greater than 1.
[2] Theoretical maximum for interference for avionic systems is given as the distance from the respective transmitter at which the interference potential becomes minimal. At further distances no potential exists. At closer distances a potential for interference exists.
[3] No radio telephone user was found within the Clear AFS area.
[4] Recommended EED safe separation distances and the corresponding power densities are given by formulas contained in Air Force Regulation 127-100.
[5] Based upon United States Certification Environment provided to aircraft manufactures by the FAA.

Abbreviations Defined: HF = high frequency; AM = amplitude modulation; FM = frequency modulation; UHF = ultra high frequency; ADF = automatic direction finder; HF = very high frequency; GPS = global positioning system; VOR = very high frequency omnidirectional range

Assumptions used in the estimation of theoretical maximum for interference:

MITRE, 1992b

a. IRI transmitter harmonics lie 80 dB below the carrier for frequencies below 45 MHz and lie 120 dB below the carrier for frequencies above 45 MHz.
b. ISR transmitter harmonics lie 80 dB below the carrier for frequencies below 1 GHz and lie 100 dB below the carrier for frequencies above 1 GHz.
c. IRI and ISR transmitter subharmonics are negligible.
d. Propagation loss is that of free space for line-of-sight paths.
e. A diffraction loss of 30 dB is applied to non-line-of-sight paths.
f. An absorption loss of 5 dB is applied to sky-wave (HF) paths.
g. The IRI waveform is CW.
h. The IRI waveform is pulsed, with a 0.5 MHz bandwidth.
i. The pattern of the IRI antenna well outside the HF band is random with no main beam or grating lobes, and the directivity is that of an isotropic radiator in the upper hemisphere (3 dB).
j. The ISR pattern is that of a parabolic dish of 1000 m^2 aperture, as specified by a semi-empirical model.
k. IRI antenna element efficiency above the HF band is - 10 dB.

MITRE, 1992d

a. Receiving system sensitivities are for the space wave only (line of sight wave plus the sky wave) and does not include the groundwave.
b. The HAARP emitters are in the far field of the receiving antennas. However, the receiving systems may be in the near field of the HAARP emitters.
c. The ambient temperatures of the receive antenna circuit, matching network, and transmission line are equal to the noise factor reference temperature at 288° K (59° F).
d. The signal/noise processing factors of the receiving systems are equal to unity.
e. The external system noise is equal to quiet-rural-noise.
f. The receive antenna directivities are equal to the peak directivities of the antennas for a worse case sensitivity to electromagnetic interference. MITRE (1992c) modifies these antenna directivities to account for the receive directivity in the direction of the HAARP emitters.

MITRE, 1992e

a. The closest ranges of the HAARP emitters to the user receiving systems are utilized to assess the worst cases of electromagnetic interference.

The HAARP emitters do not operate continuously. In the case of the IRI, a maximum of five campaigns per year, each of four week duration with operations of eight hours per day are projected. On a long term basis, the IRI may operate less than 13% of the time. The incoherent scatter radar may operate up to 12 hours per day for the same periods (approximately 19% on a long term basis), and the vertical incidence sounder may collect data routinely for several minutes every half hour for periods when the IRI is not operating as well as operating 12 hours per day during the campaigns (approximately 25% on a long term basis).

Mitigation. The maximum theoretical impact analyses suggest interference could occur for receiver systems that operate in the areas surrounding Gakona or Clear. However, similar IRI and radar systems have achieved an operations compatibility with other users of the radio frequency environment. The government is committed to achieve compatibility with the users surrounding Gakona and Clear. To reduce the opportunities for HAARP radio frequency emitters to interfere with other users of the electromagnetic environment, the government will take the following actions:

1. Minimize the potential for negative impacts by acquiring a HAARP system with low harmonic and spurious emissions. These design specifications have been set purposely to lower values than would be incorporated into commercially available transmitting equipment. This will help to ensure that the IRI harmonic and spurious emissions will be low. Specifications will be developed for the ISR and VIS to minimize the potential for out-of-band harmonic and spurious emissions.

2. Quantify with measurements the predicted HAARP impact on systems that share the electromagnetic environment. During the development testing of the HAARP emitters, the government will measure the emissions at the frequencies of receiver systems likely to be operated in the Gakona and Clear regions. An on-site radio emissions measurement program will be established to determine the local frequency usage. This measurement program will provide additional insight for cost-effectively incorporating mitigation hardware into the IRI equipment development. As HAARP is installed and tested, measurements will be made to

determine how HAARP changes the electromagnetic environment. The measurement data will be the basis for the government to initiate additional mitigative actions to help ensure that HAARP will be compatible with user receiver systems.

3. Adopt procedures to ensure that HAARP does not operate on a licensed frequency (co-channel) currently in use. The licensing requirements for radio frequency emitters dictate operations to be on specific frequencies or to employ procedures to ensure that interference does not occur to other systems that share the electromagnetic spectrum.

4. Provide a convenient, real-time method for the reporting and confirmation of interference occurrences. By request, HAARP will provide proposed research campaign details to individuals, agencies, and organizations at least two weeks prior to operation of the IRI. HAARP will have a telephone at the operations center available to report any interference or emergency conditions. HAARP personnel receiving the telephone call will work with the individual to confirm the interference and to isolate the source of the interference.

5. Achieve through mitigation a satisfactory resolution of confirmed interference occurrences. The first step toward mitigation will be to suggest and implement procedural steps for HAARP and the complainant to take to achieve interference-free operations. If these steps are not successful, hardware and procedural modifications to HAARP and/or user systems (tailored for specific interference occurrences) would be suggested and implemented. Example modifications include:

- Placement of IRI antenna nulls (reducing the power emitted in a specific direction) in the direction of affected users.

- Amplitude tapering of the IRI emissions to reduce (in all directions) the power in the antenna sidelobes.

- Use of a preselection filter for an affected user receiving system. This approach would be useful for those situations where a nearby user experiences interference caused by fundamental overload.

- Use of a low sidelobe directional user receive antenna. Such user antennas could be employed to increase the desired signal strength (as received in the mainbeam of the antenna) and reduce the unwanted HAARP emitter signals.

It is expected that the adoption of appropriate hardware and procedural modifications will result in interference-free operations. The mitigation steps will need the cooperation of affected users to understand the interference situation and to confirm a satisfactory fix is achieved.

6. Within approximately 1,300 feet of the IRI and 655 feet of the ISR, ground based use of exposed EED's will require coordination to ensure safe conditions. By request, HAARP will provide proposed research campaign details to individuals, agencies, and organizations at least two weeks prior to operation of the IRI. Appropriate warning signs will be placed along public roads and trails within 1,300 feet of the IRI and 655 feet of the ISR to advise the public not to use exposed EED's without first coordinating their usage with the HAARP site. The appropriate telephone number will be posted on the signs.

7. HAARP will employ an aircraft detection and tracking radar. If this radar detects aircraft on a track that would carry them through the warning area, the radar will automatically cue the appropriate HAARP emitters and shut them down. In coordination with the FAA, appropriate warnings will be provided for pilots to avoid flying within the radius of 9,000 feet and 16,000 feet altitude of the IRI. In addition, appropriate warnings will be provided for pilots to avoid flying within a radius of 2,500 feet and below an altitude of 4,000 feet of the ISR.

4.14.3 No Action Alternative

If the no action alternative is chosen no IRI radio waves would be transmitted. Hence, there would be no impacts to the surrounding electromagnetic environment.

4.15 ATMOSPHERE

IRI transmissions would have an insignificant effect on the earth's ozone layer and would no affect the appearence of the aurora (MRC, 1992a,b,c). The proposed IRI would transmit radi(waves of sufficient intensity to cause measurable changes in the ionosphere's electron density temperature and structure. However these changes would be insignificant both in magnitude an(duration when compared to changes induced by naturally occurring processes such as the auror: (Section 3.15).

The potential impacts of IRI transmissions on the ionosphere and ozone layer would be the sam(regardless of which of the two action alternatives are chosen. The following section discusse: the research findings concerning potential impacts on the ozone layer and the ionosphere in mor(detail.

4.15.1 Ozone Layer

The possible effects of the HAARP emitters on the ozone layer (Figure 3.15-1) were studie(using a detailed model of the thermal and chemical effects of the high frequency IR transmissions (MRC, 1992a,b). HAARP facility transmissions would raise the temperature o free electrons in the earth's ionosphere above an altitude of 50 miles, which is above the ozon layer (Figure 3.15-1). The total energy that would be emitted by HAARP transmitters in a yea would be about 200,000 times less than the energy deposited in the upper atmosphere b auroras. The raised electron temperatures would result in the production of an insignifica amount of NO_x. As mentioned in Section 3.15, NO_x are one of the primary agents that can rea(with and destroy ozone. The amount of NO_x produced by HAARP facilities would t approximately the same as that produced by starlight (MRC, 1992a), which is insignifica compared to NO_x production by other natural sources such as the aurora (MRC,1992a). : conclusion, a comparison of the modeled thermal and chemical effects of the HAAF transmissions on the production of NO_x with natural processes indicates that there would be ı measurable effects to the earth's ozone layer (MRC, 1992a).

In addition to the research identified above, the government commissioned an independent assessment on the potential effect of the HAARP IRI on upper atmosphere chemistry. The assessment involved two models. One model contains a state-of-the-art scientific understanding of the important chemistry and energy processes in the upper atmosphere. The second model is a complete three-dimensional global model of the upper atmosphere. Both models were used to examine energy deposition, electron temperatures and composition changes during the proposed HAARP radar experiments. The results showed weak local response and negligible global response in the atmosphere when compared with natural variability (Roble, 1992). The results of the independent models confirmed the previously discussed assessment that concluded there would be no measurable effects to the earth's ozone layer.

Mitigation. There would be no impacts to the ozone layer. Hence no mitigation measures would be necessary.

4.15.2 Ionosphere

The HAARP transmissions would interact with charged particles in the ionosphere. The interaction of the IRI transmissions with the ions would cause temporary increases in temperatures and decreases in electron densities within the ionosphere (Figure 3.15-2) lasting from a few seconds to several hours and possibly continuing through a polar winter night (MRC, 1992b). The temporary changes in ionospheric properties, caused by the IRI transmitted radio waves, would be many orders of magnitude less than those changes caused by variations in the sun's energy output.

The IRI would transmit radio waves over the frequency range of 2.8 to 10 megahertz. The transmitted radio wave beam would occupy a conical volume roughly 30 miles in diameter at an altitude of 300 miles. The transmitted radio waves would have up to 3.3 MW of power, only slightly higher in power than waves transmitted by radio and television stations.

Even if all the transmitted power from the IRI was absorbed by the ionosphere it would take more than 33,000 HAARP-scale IRIs, transmitting simultaneously to account for just 1 percent of the auroral ionosphere's energy budget. Another way of showing the vast difference between the amount of energy that would be dissipated in the atmosphere by the HAARP transmissions and natural processes is through a comparison of the local dissipation power in terms of power densities. The maximum power density of the IRI transmitted waves would be about 30 milliwatts per square meter (mW/m^2) at 50 miles altitude decreasing to 1 mW/m^2 at 186 miles altitude in the F region. In comparison, the densities of power dissipated by an aurora could exceed 2 W/m^2 , or roughly 2000 times greater than the expected maximum dissipation due to the absorbtion of the HAARP high frequency transmissions in the F region. Even the daily absorption of solar radiation easily exceeds the most intense, low altitude HAARP-induced energy deposition rate by a factor of ten.

Temperature Effects. The ionosphere's temperature would be detectably affected within a few milliseconds of initiating IRI transmissions. Within seconds of initiating IRI transmissions the temperature in the affected conical volume of the ionosphere would begin to rise. The magnitude of the temperature rise would be a function of transmitted wave power and duration, transmission characteristics such as frequency, and perhaps most importantly, ionospheric conditions.

Existing facilities, such as the IRI in operation at Tromso, Norway, typically can enhance F region (Figure 3.15-2) electron temperatures over a small range of altitudes by up to about 80 °F, relative to natural ambient temperatures of 1340 °F to 1727 °F. Elevated temperatures due to the IRI would rapidly return to ambient levels once transmissions are ended. The rapid return to ambient conditions would be a result of the dissipation of the extra heat energy by collision of heated electrons with ambient ions and neutral particles. In the F region the temperature would return to ambient levels in a few tens of seconds. The return time to ambient temperature levels decreases with decreasing altitude through the F and E layers and down into the D laye where the neutral gas density is about one million times greater than in the F layer. In the I

layer the temperatures would return to background levels within less than a millisecond of terminating transmissions.

Electron Density. Changes in electron density would be associated with high frequency induced temperature increases. IRI transmission induced temperature increases would cause increases in electron densities in the D, E, and F layers below approximately 124 miles above the ground and decreases in electron densities in the F layer above approximately 124 miles above ground. Two primary temperature dependent processes would affect electron densities due to IRI transmissions. One process involves the recombination of ions and electrons into neutral molecules (two or more bonded atoms), which make up the troposphere and stratosphere (Figure 3.15-1). Higher temperatures slow down the recombination rate resulting in higher electron densities. The second process involves the expansion of the ionospheric atmosphere due to heating. The expansion causes the ionospheric electron density to decrease.

Thermal expansion would be inhibited and electron recombination rates would decrease in the D, E and F layers below approximately 124 miles above ground. As a result, electron densities within the conical volume of the IRI beam could increase on the order of 20 percent. Above approximately 124 miles above ground, in the F layer, thermal expansion would prevail over reduced recombination rate effects and the electron density within the effected conical volume of the F layer would decrease. The magnitude of the decrease could range up to 10 - 15 percent over an altitude range of a few tens of miles.

Ionospheric electron densities would return to background levels over time scales similar to, though somewhat longer than, those associated with high frequency induced electron temperature effects. In the D and E layers the electron densities would immediately return to background conditions once the IRI is turned off. The decreased electron densities induced within the effected conical volume of the F layer could last anywhere from a few hours to an entire polar night. However, IRI transmission induced temporal changes to ionospheric electron densities would be insignificant to naturally induced changes.

Mitigation. There would be no significant impacts to the ionosphere. Hence no mitigation measures would be necessary.

4.15.3 No Action Alternative

If the no action alternative is chosen, no IRI radio waves would be transmitted up into the atmosphere. Hence there would be no impacts to the ionosphere or the ozone layer associated with the no action alternative.

4.16 THREATENED AND ENDANGERED SPECIES

No threatened or endangered species occur at the Gakona site, although one endangered and one threatened subspecies of the peregrine falcon could occur at the Clear site. Therefore, there would be no impacts to threatened or endangered species at the Gakona site, and it is unlikely that there would be impacts to threatened or endangered species at the Clear site. Consequently, formal consultation under Section 7 of the Endangered Species Act with the USFWS would not be required. For a discussion of potential impacts to peregrine falcons see Section 4.4 Birds.

4.17 HAZARDOUS MATERIALS AND WASTES

Hazardous materials and wastes would be stored in areas which meet the regulatory requirements. Hazardous wastes would be collected, stored, transported, and disposed of in accordance with all appropriate state, federal, and DOD regulations.

The use of pesticides, herbicides and other chemicals to aid in the control of insects, rodents, and vegetation is a normal practice to promote human health and safety. Such materials will be used and stored in accordance with the appropriate state, federal, and DOD regulations.

To minimize the potential for impacts due to accidental fuel spills during the HAARP operation, fuel transfer from delivery trucks would be conducted in a safe manner. The above ground fuel tanks would have secondary containment that would hold the contents of the largest tank plus sufficient free board to allow for precipitation. Periodic removal of water from precipitation would be required to ensure that the capacity of the secondary containment would not be diminished. The government would prepare a Spill Prevention, Containment and Countermeasure Plan before fuel tanks are filled.

Petroleum products are required for the operation of HAARP facilities, regardless of the site selected. The quantity of petroleum products stored would vary from site to site (approximately 200,000 gallons at the Gakona site, and only several thousand gallons at the Clear site). The delivery and storage points at both sites would be at least 2500 feet from the nearest HAARP emitter. Typical concerns relating to petroleum products and radio frequency produced electric fields relate to the generation of an electric spark that can cause explosions or fires. USAF Technical Order 31Z-10-4, Section II states that an area with a power density in excess of 50,000 watts per square meter is considered hazardous to fuel handling and storage operations. This value is large compared to human health and safety standards and would not be exceeded. It can therefore be concluded that fuel handling and electric field safety concerns are not an issue at the either of the proposed HAARP sites.

4.17.1 Gakona Site

Use of the Gakona site would require construction of new hazardous material storage areas for typical facility operation and maintenance. Storage areas would be designed and constructed in accordance with the appropriate state, federal and Air Force regulations. Disposal plans would be developed in accordance with the appropriate state, federal, and Air Force regulations.

The hazardous material most used at the Gakona site would be diesel fuel used for power generation. The quantity of fuel stored on site would be approximately 200,000 gallons (4 - 50,000 gallons above surface cylindrical steel tanks). Other hazardous materials would be typical petroleum based products used in the operation and maintenance of mechanical engines (engine oil, hydraulic oil, grease, ethylene glycol, engine cleaner, etc.). Other hazardous materials would be paints, solvents, cleaners, and other such janitorial-type supplies used for building and facility maintenance.

4.17.2 Clear Site

Use of the Clear site would require either construction of new hazardous material storage areas dedicated to the HAARP facility or use of existing storage areas on Clear AFS. Disposal of wastes would be integrated with the disposal programs in place at Clear AFS.

Much less hazardous materials would be used, stored, and generated at the Clear site in comparison to the Gakona site. This is because there would be no need for a diesel-fired powerplant at the Clear site. Since it is anticipated that electrical power would be obtainable from the existing Clear AFS coal-fired powerplant or the commercial power grid, the quantity of fuel required at the Clear site would be only several thousand gallons. Other hazardous materials include paints, solvents, cleaners, and other such janitorial-type supplies used for building and facility maintenance.

4.17.2 No Action Alternative

No hazardous materials or wastes would be stored or generated as a result of the no action alternative, with the exception of those associated with the reclamation of the Gakona site. During reclamation of the Gakona site small quantities of fuel would likely be stored on site and small quantities of waste oil would be generated. Procedures for storage and disposal of these wastes would follow the appropriate regulations.

4.18 IRRETRIEVABLE COMMITMENT OF RESOURCES

Construction and operation of HAARP would require the use of nonrenewable resources such as fuels, construction materials, and land. Heavy equipment and haul trucks would use diesel fuel and gasoline during construction. During operation, scientists, technicians, and employees would use small amounts of gasoline. The power generator at the Gakona site would consume about 200,000 gallons of diesel fuel per campaign. At the Clear site an increment over the amount of coal already being consumed at the Clear AFS or by the commercial source would be used. The amount of fuel consumed at either site would represent a small fraction of the fuel used in the Clear or Gakona regions.

Construction materials used to build the HAARP facilities include gravel, aggregate, sand, cement, metal, and wood. Except for wood, all these materials are considered to be nonrenewable. Therefore, the project would contribute, in a minor measure, to depletion of local resources of those materials. The amount consumed, however, would be inconsequential when compared to the regional or national consumption.

The facilities would physically occupy about 51 acres of land at the Gakona site and about 78 acres of land at the Clear site. Of this land, 18 acres and 36 acres of wetlands would be lost at the Gakona and Clear sites, respectively. Loss of land or wetlands would be insignificant as compared to the surrounding similar land and wetlands and would represent a minor commitment of those resources.

The no action alternative would require small quantities of fuel for the reclamation of the Gakona site. No other commitment of irretrievable resources would be associated with the no action alternative.

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APPENDIX A

SCIENTIFIC NAMES FOR SPECIES MENTIONED IN TEXT

COMMON NAME	SCIENTIFIC NAME
BIRDS:	
American dipper	*Cinclus mexicanus*
American golden-plover	*Pluvialis dominica*
American kestrel	*Falco sparverius*
American pipit	*Anthus rubescens*
American robin	*Turdus migratorius*
American tree sparrow	*Spizella arborea*
American wigeon	*Anas americana*
Arctic loon	*Gavia arctica*
Arctic tern	*Sterna paradisaea*
Bald eagle	*Haliaeetus leucocephalus*
Bank swallow	*Riparia riparia*
Black scoter	*Melanitta nigra*
Black-bellied plover	*Pluvialis squatarola*
Black-capped chickadee	*Parus atricapillus*
Blue-winged teal	*Anas discors*
Bohemian waxwing	*Bombycilla garrulus*
Bonaparte's gull	*Larus philadephia*
Boreal chickadee	*Parus hudsonicus*
Boreal owl	*Aegolius funereus*
Bufflehead	*Bucephala albeola*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Common goldeneye	*Bucephala clangula*
Common loon	*Gavia immer*
Common merganser	*Mergus merganser*
Common raven	*Corvus corax*
Common redpoll	*Carduelis flammea*
Common snipe	*Gallinago gallinago*
Dark-eyed junco	*Junco hyemalis*
Downy woodpecker	*Picoides pubescens*
Fox sparrow	*Passerella iliaca*
Gadwall	*Anas strepera*
Glaucous-winged gull	*Larus glaucescens*
Golden eagle	*Aquila chrysaetos*
Gray jay	*Perisoreus canadensis*
Great gray owl	*Strix nebulosa*
Great horned owl	*Bubo virginianus*

COMMON NAME	SCIENTIFIC NAME
BIRDS (Continued):	
Greater scaup	*Aythya marila nearctica*
Grebe	*Podiceps* sp.
Green-winged teal	*Anas crecca*
Gyrfalcon	*Falco rusticolus*
Hairy woodpecker	*Picoides villosus*
Hoary redpoll	*Carduelis hornemanni*
Horned grebe	*Podiceps auritus*
Lapland longspur	*Calcarius lapponicus*
Lesser scaup	*Aythya affinis*
Lesser yellow legs	*Tringa flavipes*
Long-billed dowitcher	*Limnodromus scolopaceus*
Mallard	*Anas platyrhynchos*
Merlin	*Falco columbarius*
Mew gull	*Larus canus*
Northern flicker	*Colaptes auratus*
Northern harrier	*Circus cyaneus*
Northern hawk owl	*Surnia ulula*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Old duck squaw	*Clangula hyemalis*
Osprey	*Pandion haliaetus*
Pine grosbeak	*Pinicola enucleator*
Red phalarope	*Phalaropus fulicaria*
Red-breasted merganser	*Mergus serrator*
Red-necked grebe	*Podiceps grisegena*
Red-necked phalarope	*Phalaropus lobatus*
Red-tailed hawk	*Buteo jamaicensis*
Red-throated loon	*Gavia stellata*
Redhead	*Aythya americana*
Redpoll spp.	*Carduelis spp.*
Ring-necked duck	*Aythya collaris*
Rough-legged hawk	*Buteo lagopus*
Ruffed grouse	*Bonasa umbellus*
Rusty blackbird	*Euphagus carolinus*
Sandhill crane	*Grus canadensis*
Scaup	*Aythya spp.*
Sharp-shinned hawk	*Accipter striatus*
Sharp-tailed grouse	*Tympanuchus phasianellus*

COMMON NAME	SCIENTIFIC NAME
BIRDS (Continued):	
Short-eared owl	*Asio flaammeus*
Snow bunting	*Plectrophenax nivalis*
Spruce grouse	*Dendragapus canadensis*
Surf scoter	*Melanitta perspicillata*
Tree swallow	*Tachycineta bicolor*
Trumpeter swan	*Cygnus buccinator*
Tundra swan	*Cygnus columbianus*
Varied thrush	*Ixoreus naevius*
Violet-green swallow	*Tachycineta thalassina*
White-crowned sparrow	*Zonotrichia leucophrys*
White-fronted goose	*Anser albifrons*
White-winged crossbill	*Loxia leucoptera*
Willow ptarmigan	*Lagopus lagopus*
Yellow-rumped warbler	*Dendroica coronata*
MAMMALS:	
Arctic ground squirrel	*Citellus parryi*
Arctic shrew	*Sorex arcticus*
Beaver	*Castor canadensis*
Black bear	*Ursus americanus*
Brown bear	*Ursus arctos*
Caribou	*Rangifer tarandus*
Coyote	*Canis latrans*
Ermine	*Mustela erminea*
Fox	*Vulpes* sp.
Gray wolf	*Canis lupus*
Lemmings	*Synaptomys borealis*
Lynx	*Felis lynx*
Marten	*Martes americana*
Mink	*Mustela vison*
Moose	*Alces alces*
Muskrat	*Odantra zibethicus*
Otter	*Lutra canadensis*
Red fox	*Vulpes vulpes*
Red squirrels	*Tamiasciurus hudsonicus*
Short-tail weasels	*Mustela erminea*
Snowshoe hare	*Lepus americanus*
Wolverine	*Gulo gulo*

COMMON NAME	SCIENTIFIC NAME
THREATENED AND ENDANGERED:	
American peregrine falcon	*Falco peregrinus anatum*
Arctic peregrine falcon	*Falco peregrinus tundrius*
FISH:	
Arctic char	*Salvelinus alpinus*
Arctic grayling	*Thymallus arcticus*
Burbot	*Lota lota*
Chinook salmon	*Oncorhynchus tschawytscha*
Chum salmon	*Oncorhynchus keta*
Coho salmon	*Oncorhynchus kisutch*
Dolly Varden char	*Salvelinus malma*
King salmon	*Oncorhynchus tschawytscha*
Lake trout	*Salvelinus namaycush*
Longnose sucker	*Catostomus catostomus*
Pacific lamprey	*Entosphenus tridentatus*
Rainbow trout	*Oncorhynchus mykiss*
Round whitefish	*Prosopium cylindraceum*
Slimy sculpin	*Cottus cognatus*
Sockeye salmon	*Oncorhynchus nerka*
Steelhead trout	*Oncorhynchus mykiss*
FLORA:	
Alder	*Alnus* sp.
Aspen	*Populus tremuloides*
Balsam popular	*Populus balsamifera*
Birch	*Betula* sp.
Black spruce	*Picea mariana*
Bog blueberry	*Vaccinium*
Labrador tea	*Ledum groenlandicum*
Sedges	*Cyperaceae*
Sphagnum moss	*Sphagnum* sp.
Tamarack	*Larix laricina*
White spruce	*Picea glauca*
Willow	*Salix* sp.

Sources:

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American Ornithologists' Union. 1983. *Check-list of North American Birds, 6th edition & supplements.*

APPENDIX B

PERMITTING

A. Federal Regulations

1. National Historic Preservation Act (NHPA)

a. Section 106 Review Process

The NHPA establishes the Advisory Council on Historic Preservation (ACHP) to ensure that significant archaeological and/or historical properties are not lost due to federal construction projects. Section 106 of the NHPA establishes an archaeological survey and testing process to determine the eligibility of sites for potential listing in the National Register of Historic Places.

2. Army Corps of Engineers, Regulatory

a. Discharge of Dredged or Fill Material Into U.S. Waters (Section 404 of the Clean Water Act)

This permit regulates proposals to dredge or fill U.S. waters and adjacent wetlands, pursuant to Section 404 of the Clean Water Act (33 USC 1344). The proposal is evaluated by the Corps District Engineer based upon conservation, economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, navigation, recreation, water quality and the general needs and best interests of the public.

The issuance of this permit will also require the applicant to obtain a Section 401 Water Quality Certification from the State of Alaska. The Section 404 Application jointly serves as an application for a 401 Water Quality Certification.

To facilitate parallel reviews, the 404 application can be submitted at the same time the Draft Environmental Impact Statement (DEIS) is released for public review. Wetland fill for the project cannot commence until the Section 404 permit is issued.

3. Environmental Protection Agency

a. Oil Storage Facilities Spill Prevention, Containment and Countermeasure (SPCC) Plans

These plans are required by the EPA for oil storage facilities which (a) store over 660 gallons in a single above-ground container; (b) store over 1320 gallons in multiple tanks above ground; or (c) store over 4,200 gallons below ground. It is likely that plans will be needed both for temporary oil storage facilities (during construction) and for the permanent powerplant fuel storage facility (assuming a direct-drive diesel powerplant).

The SPCC plans require detailed information on quantities and type of oil stored, oil containment facility, spill contingency plans, and preventative maintenance procedures. Plans must be reviewed every 3 years to assure the use of the best available spill prevention and cleanup technology. The plans must be developed within 6 months of beginning operation; mobile or temporary facilities must have a plan developed prior to beginning operations.

b. National Pollutant Discharge Elimination System (NPDES) Permit

This permit regulates the discharges allowed from point sources (e.g. pipes, ditches, conduits) into U.S. Waters. Several different types of NPDES permits may be required for HAARP facilities, depending upon final site design considerations. Permits may be required for sewage treatment plants, powerplant facilities, gravel pit dewatering, cement batching, and any discharge of wastewater and storm water. Information to be submitted includes proposed treatment, techniques for the removal of solids, quantity and quality of the receiving waters, and content of discharge. Upon review of the applications, EPA may issue a minor letter, or an NPDES permit. A NEPA review is required for all new sources. To the extent possible, any sources will be covered in HAARP's initial NEPA document.

c. Resource Conservation and Recovery Act (RCRA) Permit

This permit is required for the treatment, storage or disposal of hazardous waste materials. Fuel oils, lubrication oils, and solvents are examples of hazardous waste which may be generated by the HAARP facilities. Detailed design reviews of the permanent power and operations facilities will be required to determine whether RCRA permits are necessary.

The application has two parts. Part A requires information on the purpose of the facility, engineering plans and specifications for the facility, proposed treatment, storage, and handling processes for hazardous wastes at the facility, state and Federal permits applied for or received, and a topographic map (if applicable) indicating the location of facility intake and discharge structures. Part B requires information on chemical analysis of expected wastes, security procedures, contingency plans and (depending upon location) the facility's seismic and floodplain zoning.

4. U.S. Fish & Wildlife Service (USFWS)

a. Endangered Species Act

Consultation, either informal or formal, with the USFWS is required for any action which may affect endangered or threatened wildlife or result in the destruction or modification of their critical habitats (e.g. rearing, nesting, spawning, or feeding areas). Formal consultation is not required if it is determined through a biological assessment or informal consultation that the project is not likely to adversely affect any listed species or habitat.

5. Federal Aviation Administration (FAA)

a. Notice of Structures which may Interfere with Flight Paths

A "Notice of Proposed Construction or Alteration" must be submitted to the FAA Regional

Office at least 30 days before beginning construction of any structure which may interfere with airplane flight paths. The notices will be needed for construction of the HAARP transmitter. The FAA requires detailed information on the location, height, ground elevation, work schedule, and proposed lighting for the proposed facility.

Note: It is advisable for the government to consult with the FAA and the Federal Communications Commission (FCC) on potential interference between HAARP operations and commercial aircraft communications and ground-based communications and the possible establishment of warning areas or restricted airspace.

B. STATE REGULATIONS

1. Alaska Department of Environmental Conservation (ADEC)

a. Water Quality Certification

This certificate is required to assure that Federal permits issued for a facility do not result in a violation of Alaska's Water Quality Standards. The Dredge and Fill Permit (Section 404) issued by the COE and the National Pollutant Discharge Elimination System (NPDES) review by EPA will automatically trigger a request for issuance of this certificate from the DEC. The DEC will be particularly interested in the proposed methods of gravel extraction from permafrost regions, the effects of dredge, fill, and leveling operations on water draining, the potential for erosion, the proposed methods of clearing, and the proposed means of overburden stockpiling and disposal. The state Water Quality Certification can be scheduled concurrent with submission of Section 404 and NPDES Federal Permits.

b. Air Quality Permit to Operate

Any facility producing air contaminant emissions in the state must secure this permit. This permit will be required for the generators providing permanent power for the HAARP

transmitting antenna. In addition, this permit will be required for any additional generators required for on-site diagnostics or for any generators which the contractor requires for site construction activities. The state permit implements the requirements of the Federal Clean Air Act.

The application requires (at a minimum) (a) set of plans and specifications of the proposed facility; (b) maps and/or photos showing the proposed location; (c) an engineering report outlining the proposed method of operation; (d) a description of air quality control devices (e) an evaluation of the facility's effects on ambient air quality; and (f) a schedule for construction.

If the facility is subject to Prevention of Significant Deterioration (PSD) review (see PSD standards below), additional information is required on (a) air quality and meteorological data for the facility location; and (b) the impact of maximum emissions on visibility, vegetation, and soils. Demonstration will be required to document the use of best available air quality control technology and the facility's maximum emissions' effects on ambient air standards. PSD reviews may also require a public hearing, if necessary. Application preparation can begin immediately. Air Quality Permits to Operate must be filed at least 30 days prior to construction or installation of a facility.

c. Prevention of Significant Deterioration

As mentioned above, certain emission sources will require this permit to prevent significant deterioration of air quality in areas cleaner than required by the Clean Air Act's National Ambient Air Quality Standards (NAAQS). Certain designated sources of air emissions which emit more than 100 tons per year of air pollutant, and all other sources emitting over 250 tons per year of any air pollutant will require a PSD permit.

The facility must (a) not violate the PSD Standards; (b) not violate the NAAQS; and (c) use the Best Available Control Technology. The application will be reviewed within 30 days. A 30-day public comment period and opportunity for public hearings must also be provided. Construction

must begin within 18 months of permit issuance. Permits are valid for the life of the facility.

d. Air Quality Permit to Open Burn

This permit regulates open burning of all waste products in the state. It may be required for burning of slash and vegetation during land clearing activities. Although ADEC prefers wood chipping or alternate methods, the contractor may prefer burning which would require a burning permit.

e. Plan Review for Sewerage Systems or Water and Wastewater Treatment Works

This plan review provides a minimum standard for construction of facilities which collect, treat and dispose of wastewater and obtain, treat and distribute potable water. The state may require that the designs for sewer systems and treatment works used in remote areas have a successful history of operation in similar environments.

If the designs might affect the spawning or migration of salmon or violate State Water Quality Standards, additional information on construction schedules and proposed mitigation measures will also be required. A package plant may be installed only if the ADEC determines that the plant can treat domestic wastewater for at least one year under expected conditions or that the plant meets or exceeds National Sanitation Foundation certification criteria.

The ADEC will normally provide an approval of the plant design within 30 days of plan receipt. The State Water Quality Certification and NPDES review may be required prior to beginning operations of facilities for wastewater disposal. In addition, a wastewater disposal permit from ADEC is required prior to disposing the wastewater.

f. Solid Waste Disposal Permit

This permit is required to eliminate the potential for improper solid waste disposal practices. If HAARP elects to establish on-site solid waste disposal areas rather than utilizing existing local landfills, then these HAARP solid waste disposal sites must be permitted by ADEC. On-site batching of asphalt and concrete would require wastewater or solid waste permits. The local landfill at Glennallen should be consulted to determine if the anticipated construction and operation wastes are already approved for this facility. The Glennallen landfill is approved for sewage sludge disposal. Disposal in existing landfills is the preferred approach.

If a permit is necessary, the permit application must contain, at a minimum, (a) detailed plans and specifications for the site; (b) maps and/or aerial photographs of the proposed site; (c) a description of the expected operation of the site (including appropriate mitigation measures); and (d) an evaluation of the site's water pollution potential.

g. Wastewater Disposal Permit

This permit is required to prevent water pollution resulting from improper wastewater disposal systems and practices. If a completed and approved NPDES permit from EPA is in place, ADEC will waive the requirement for this permit and adopt the NPDES permit as the state approved permit for wastewater disposal. Pre-application meetings with ADEC and EPA Regional Officials will clarify the expedited procedures for issuance of waiver of this permit.

2. Alaska Department of Natural Resources (ADNR)

a. Burning Permit

This permit is required for the burning of material in areas of the state designated by the Commissioner of DNR. They are normally required during the fire season (May 1 - September 30). This permit will be required in lieu of the DEC open burning permit for areas falling under

DNR jurisdiction.

b. Water Rights Permit

This permit is required for appropriation of waters of the State. If state waters are used for construction or operation of the HAARP facilities then this permit would be required.

The permit application must include detailed information on (a) the location of the source of water, (b) the proposed means of appropriation (e.g. dam, well) (c) the quantity of water appropriated (d) the purpose and location of the facilities to be using the water. The application will initiate a 15-day public comment period. A permit will be issued to develop the water source.

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APPENDIX C

ENDANGERED SPECIES COORDINATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anchorage Field Office
Ecological Services and Endangered Species
605 West 4th Avenue, Room 62
Anchorage, Alaska 99501

IN REPLY REFER TO:
WAES

JUN 1 1992

R. Earl Good, SES
Director of Geophysics
Department of the Air Force
Phillips Laboratory (AFSC)
Hanscom Air Force Base, Massachusetts 01731-5000

Dear Mr. Good:

This responds to your letter dated April 24, 1992, requesting information on threatened or endangered species on the proposed area of the High Frequency Active Auroral Research Program illustrated on the enclosed map. Based on a review of our office files there are no threatened or endangered species in these areas. No further consultation pursuant to Section 7 of the Endangered Species Act of 1973, as amended, is required.

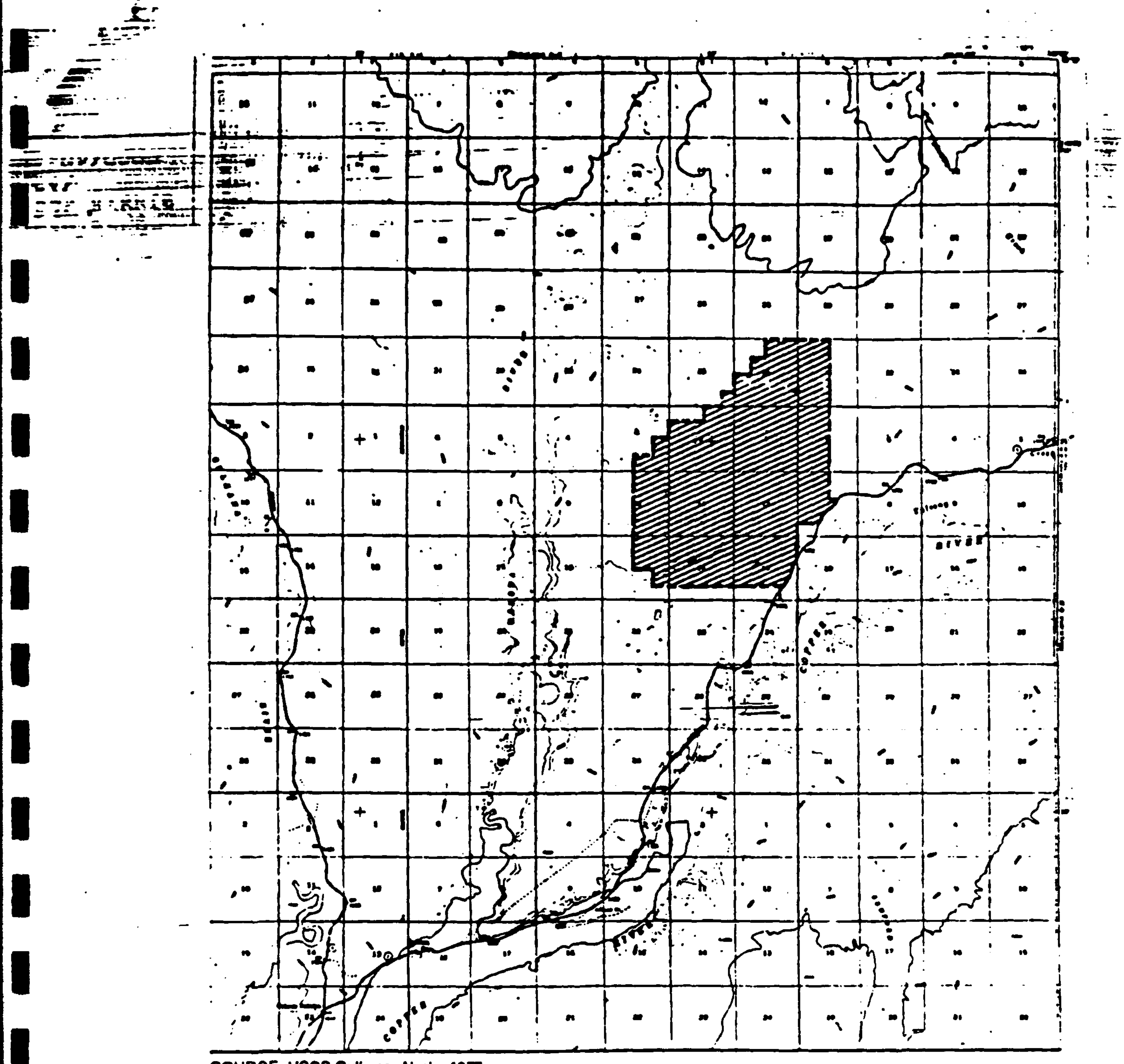
If you have any questions regarding this, please contact Nancy Zapotocki at (907) 271-2888.

Sincerely,

Sonce de Vries

Sonce de Vries
Acting Field Supervisor

Enclosed



SOURCE: USGS Gulkana, Alaska 1977

U.S. Air Force Property Boundary

FIGURE 2.1-7. GULKANA POTENTIAL SITE

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

Ecological Services, Fairbanks
Endangered Species
1412 Airport Way
Fairbanks, AK 99701
September 18, 1992

John L. Heckscher
Ionospheric Physics Division
Department of the Air Force
Phillips Laboratory (AFSC)
Hanscom Air Force Base, MA 01731-5000

Dear Mr. Heckscher:

This responds to your September 2, 1992, letter requesting a list of endangered and threatened species and critical habitats pursuant to Section 7 of the Endangered Species Act of 1973, as amended. This information is being provided for the Alternative Site for the HF Active Auroral Research Program (HAARP) near Clear, Alaska and Browne, Alaska.

Two listed species occur in the Clear and Browne area. The endangered American peregrine falcon (*Falco peregrinus anatum*) nests in the forested areas of interior Alaska, and migrates through the area during spring and fall migration. The threatened arctic peregrine falcon (*Falco peregrinus tundrius*) nests in the tundra areas of northern and western Alaska and also migrates through the area during spring and fall migration. There is no designated critical habitat in Alaska.

There are no known nest sites of American peregrine falcons within 10 miles of Clear or Browne. As mentioned above, some arctic and American peregrine falcons likely migrate through the area each spring and fall, and the Fish and Wildlife Service will be concerned with the potential for migrating peregrine falcons and other migrant bird species colliding with the antenna and associated support wires.

Thank you for your concern for endangered species. Please contact me if you need additional information.

Sincerely,

Skip Ambrose

Skip Ambrose
Branch Chief